NAVY
PROPOSAL SUBMISSION
INTRODUCTION

The responsibility for the implementation, administration and management of the Navy SBIR program is with the Office of Naval Research (ONR). The Navy SBIR Program Manager is Mr. Vincent D. Schaper ((703) 696-8528). The Deputy SBIR Program Manager is Mr. John Williams ((703) 696-0342**).** If you have any questions, problems following the submission directions, or inquiries of a general nature, contact one of the above persons. Phase I proposals must be received by **11 August 1999**. All Phase I proposals and subsequent Phase II Appendices A, B, and E must be submitted to:

Office of Naval Research

ONR 362 SBIR
800 North Quincy Street, RM 633
Arlington, VA 22217-5660

The Navy's SBIR program is a mission-oriented program, which integrates the needs and requirements of the Navy through R&D topics, which have dual-use potential. All Navy SBIR topics fall within the DOD Science and Technology areas and the Navy Science areas, listed in Table 1. Navy topics will be funded from these areas according to a priority it has established to meet its mission goals and responsibilities. Information on the Navy SBIR Program can be found at (**http://www.onr.navy.mil/sbir**). Additional information pertaining to the Department of Navy mission can be obtained by viewing various Navy World Wide Web sites at http://www.navy.mil

UNIQUE NAVY REQUIREMENTS:

1. Navy requires Appendix A, B and E to be submitted electronically through the Navy SBIR/STTR Website. The company must print out the forms directly from the Website, sign the forms and submit them with their proposal.
2. All Phase I award winners must electronically submit Phase I summary report through the website at the end of their Phase I.
3. Phase II award winners must also submit Phase II Summary reports through this same website.
4. The Navy requires that all Phase II proposers submit Appendix A, B & E through the Navy SBIR/STTR Website and mail only the appendices to the Navy SBIR Program Office listed above.
5. The requirements and time frames for Navy Fast Track submission have been modified and are described below.
6. The Navy only accepts proposals with a base effort less than $70,000 with an option less than $30,000.

NEW IN FY 1999:

The Navy will allow firms to include with their proposals, success stories that have been submitted through the Navy SBIR/STTR Website at (**http://www.onr.navy.mil/sbir**). A Navy Success Story is any follow-on funds that a firm has received from past Phase II Navy SBIR or STTR awards. To qualify the firm must submit these success stories no later than **23 July 1999,** through the Navy SBIR Website. The success story should then be printed and included as appendices to the proposal. These pages will not be counted towards the 25-page limit.

The success story information will be used in the evaluation of the third criteria Commercial Potential, (listed in Section 4.2 of this solicitation) which includes Companies Commercialization Report (Appendix E) and the strategy described to commercialize the technology discussed in the proposal. Commercialization is viewed as any follow-on funds, from the DOD, DOD contractors or the private sector, used to further develop the technology or from sales of a product. The Navy is very interested in companies that transition SBIR efforts directly into Navy and DOD programs and/or weapon systems. The proposing company should make reference to the attached success stories in the Commercialization Strategy section of their proposal so the evaluator knows to look for them. If a firm has never received any Navy SBIR Phase II it will not count against them, and they will be evaluated on the other evaluation criteria listed in Section 4.2 Phase I Evaluation Criteria.

Effective with the fiscal year (FY) 2000, no Navy activity will issue a Navy SBIR Phase II award to a company where the elapsed time between the completion of the Phase I award and the actual Phase II award date is eight (8) months or greater; unless the process and the award has been formally reviewed and approved by the Navy SBIR Program Office. Also, any SBIR Phase I contract that has been extended by 'no cost extensions' beyond one (1) year will be ineligible for a Navy SBIR Phase II award using SBIR funds.

The Navy has adopted a New Phase II Enhancement Plan to encourage transition of Navy SBIR funded technology to the Fleet. Since the Law (PL102-564) permits Phase III awards during Phase II work, the Navy will provide a 1 to 4 match of Phase II to Phase III funds that a company obtains from an acquisition program up to $250,000 in additional SBIR funds.

PROPOSAL SUBMISSION CHECKLIST:

SUBMIT YOUR PROPOSAL(S) WELL BEFORE THE DEADLINE.

All of the following criteria must be met or your proposal will be REJECTED.

1. You must use the electronic format described in the section <u>Electronic Submission</u> described below. The Navy will not accept any proposals that do not have electronic forms of Appendix A, B, and E. The electronic appendices submitted must match the paper copies submitted via mail/express delivery.

2. An electronic version of Company Commercialization Report (Appendix E) must be submitted with all proposals. Even if you have no Phase II or Phase III information to report.

3. Your Phase I proposed cost for the base effort can not exceed $70,000. Your Phase I Option proposed cost can not exceed $30,000. The costs for the base and option should be clearly separate and identified on Appendix A, the cost proposal and in the work plan section of the proposal.

4. Your proposal must be received on or before the deadline date. The Navy will not accept late proposals, or incomplete proposals. If you have any questions or problems with submission of your proposal allow yourself time to contact the Navy and get an answer to your question. Submit Appendices early, as computer traffic increases, computer speed slows down. <u>Do not wait until the last minute.</u>

ELECTRONIC SUBMISSION OF APPENDICES:

Submit your SBIR proposal to the Navy using the online submission. This site allows your company to come in any time (prior to the closing of the solicitation) to edit or print out your appendices. **The Navy <u>WILL NOT</u> accept any form from this book or any electronic download version except those from the Navy SBIR Website as valid proposal submission forms for the Appendix A, B and E.** <u>Proposers must use the following procedures</u>.

A. Go to http://www.onr.navy.mil/sbir and click on SBIR Phase I box, click on "Submission", then click on "Submit or Edit Phase I Appendix A and B and follow instructions.

B. Fill out all the information requested. The screen format will look different then the forms in the solicitation. Once you have filled in the data, follow the instructions to electronically save/submit appendices. That is, make sure you click on the Save/Submit button, which will save your appendix to the Navy server. You will still be able to return and edit this text up to solicitation closing, at which time the Navy will close down the site. Your electronically submitted version should match the signed paper appendices submitted with your proposal.

C. After you click on the Save/Submit button, follow instructions to print out the appendices and sign them. The printed forms from the website may look different than the forms in book and the signature block may appear on the second page. The Navy requires you to include these forms with the mailed hard copy of your proposal. Do not use any other version of the signed forms.

D. Mail the signed Appendix A/B and E forms along with one original and four copies of your entire proposal (the copies should include four copies of the signed Appendix A, B and E forms) to the Navy SBIR Program Office at the above address.

ELECTRONIC SUBMISSION OF PROJECT REPORTS:

The submission of an electronic Phase I Summary Report will now be required at the end of Phase I. The Phase I Summary Report is a summary of Phase I results, includes potential applications and benefits, and should not exceed 750 words. It should require minimal work from the contractor because most of this information is required in the final report. The summary of the final report will be submitted through the Navy SBIR/STTR Website at: http://www.onr.navy.mil/sbir, click on "Submission", then click on "Submit a Phase I or II Summary Report". If your company does not have access to the Internet on your computer consult your local library or local computer service store.

The Navy is initiating this new program to help increase the awareness and implementation of SBIR funded efforts. The goal is to increase the market potential and transition of SBIR projects by increasing the visibility and ease in accessing information about SBIR projects to DOD, government and DOD industry contacts. This should facilitate the transition of these projects into follow-on efforts and bring additional revenue to the SBIR Company.

To do this the Navy is asking companies to provide information on the status and benefits of their technology developments so that this information can be put into a media that others can easily access and review. The Navy plans to redistribute this information to a wide audience using such tools as the Navy Webpage, Accomplishment Book and a new interactive Navy SBIR Website. This will help provide parties with technical challenges or those with the need to implement new technology, with a user-friendly mechanism to access and identify SBIR companies that can provide them with solutions. This information should be **non-proprietary** yet detailed enough to provide the interested transition partner with enough knowledge to understand the potential use and benefit to their program.

NAVY FAST TRACK DATES AND REQUIREMENTS:

All Fast Track Applications and required information must be sent to the Navy SBIR Program Manager at the address listed above and to the designated Contracting Officers Technical Monitor (the Technical Point of Contact (TPOC) for the contract and the appropriate Point of Contact at the end of this Introduction). The dates and information required by the Navy are the same as the dates and information required under the DOD Fast Track described in the front part of this solicitation.

ARE YOU A SUPPORT CONTRACTOR FOR A NAVY ACTIVITY ?

Do you have employees occupying space in a Navy activity? Or do you have a support contract to provide services outside of an SBIR Phase I, II or III contract award? Then you must indicate so on the Appendix A form. The Navy is concerned with potential conflict of interest and if you reply yes to either of the above you may be precluded from participation in the Navy's SBIR Program.

YOUR SUBMISSION TO THE NAVY SBIR PROGRAM:

This solicitation contains a mix of topics. When preparing your proposal keep in mind that Phase I should address the feasibility of the solution to the topic. Be sure that you clearly identify the topic your proposal is addressing. The Phase I option should address the transition into the Phase II effort. The Phase II is the demonstration of the technology that was found feasible in Phase I. Only those Phase I awardees which have been invited to submit a Phase II proposal by the Navy technical point of contact (TPOC) during or at the end of a successful Phase I effort will be eligible to participate for a Phase II award (with the exception of Fast Track Phase II proposals). If you have been invited to submit a Phase II proposal to the Navy by the TPOC, obtain a copy of the Phase II instructions from the Navy SBIR Webpage or request the instructions from the Navy SBIR Program officer. Phase III efforts should also be reported to the SBIR program office noted above.

The Navy will provide potential awardees the opportunity to reduce the gap between Phases I and Phase II if they provide a $70,000 maximum feasibility Phase I proposal and a fully costed, well defined ($30,000 maximum) Phase I Option to the Phase I. **<u>The Navy will not accept Phase I proposals in excess of $70,000 (exclusive of the Phase I option)</u>.** The technical period of performance for the Phase I should be 6 months and for the Phase I option should be 3 months. The Phase I Option should be the initiation of the next phase of the SBIR project (i.e. initial part of Phase II). The Navy will also offer a "fast track" into Phase II to those companies that successfully obtain third party cash partnership funds ("fast track" is described in Section 4.5 of this solicitation). When you submit a Phase II proposal it should consist of three elements: 1) a $600,000 maximum demonstration phase of the SBIR project (i.e. Phase II)(Phase II efforts are for two (2) years no more, no less....Phase II options are for an additional six (6) months...a waiver may be granted only from the NAVY SBIR Program Office); 2) a transition or marketing plan (formally called a "commercialization plan") describing how, to whom and at what stage you will market your technology to the government and private sector; 3) a Phase II Option ($150,000 maximum) which would be a fully costed and well defined section describing a test and evaluation plan or further R&D if the transition plan is evaluated as being successful. You must also submit your Phase II appendix A, B & E electronically to the Navy SBIR Program Office at the address above. While Phase I proposals with the option will adhere to the 25 page limit (section 3.3), Phase II proposals together with the Phase II Option will be limited to 40 pages (unless otherwise directed by the TPOC or contract). The transition plan should be in a separate document.

The Navy will evaluate and select Phase I proposals using scientific review criteria based upon technical merit and other criteria as discussed in this solicitation document. Due to limited funding, the Navy reserves the right to limit awards under any topic and only proposals considered to be of superior quality will be funded.

TABLE 1. NAVY MISSION CRITICAL SCIENCE AND TECHNOLOGY AREAS

TECHNOLOGY AREAS	SCIENCE AREAS
Aerospace Propulsion and Power	Atmospheric and Space
Aerospace Vehicles	Biology and Medicine
Battlespace Environment	Chemistry
Chemical and Biological Defense	Cognitive and Neural
Clothing, Textiles and Food	Computer Sciences
Command, Control and Communications	Electronics
Computers, Software	Environmental Science
Conventional Weapons	Manufacturing Science
Electron Devices	Materials
Electronic Warfare	Mathematics
Environmental Quality and Civil Engineering	Mechanics
Human-System Interfaces	Ocean Science
Manpower, Personnel and Training Systems	Physics
Manufacturing Technology	Terrestrial Sciences
Materials, Processes and Structures	
Medical	
Sensors	
Surface/Undersurface Vehicles/Ground Vehicles	
Modeling and Simulation	

NAVY 99.2 SBIR WORD/PHRASE INDEX

WORD/PHRASE — TOPIC NO.

NAVY 99.2 SBIR TITLE INDEX

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N99-175 TITLE: Failure Detection System for Composite Joints

N99-176 TITLE: Selective Depainting and Precision Cleaning

N99-177 TITLE: Innovative Protective Coating Systems for Aircraft

N99-178 TITLE: Non-Chromated Flexible Primer

N99-179 TITLE: Innovative Thermal Barrier Technology for Exterior Aircraft Structures

N99-180 TITLE: Design Assistant and Software Tools for System Identification and Adaptive Fault-Tolerant Control

N99-181 TITLE: Weight Efficient Corrosion Resistant Composite Heat Exchangers

N99-182 TITLE: Low Cost Turbojet Engine for Expendable Target Applications

N99-183 TITLE: Motion Coupling in a Deployable Virtual Environment Trainer

N99-184 TITLE: Alternate Time Management Schemes for Use in High Level Architecture (HLA) Federate Simulation

N99-185 TITLE: Client/Server Part Task Trainer Interface

N99-186 TITLE: Shallow Water Directional Noise Measurement Sensors

N99-187 TITLE: High-Bandwidth Scene Projector Drive Electronics

N99-188 TITLE: Novel Signal Processing Algorithms to Exploit and Classify Active Sonobuoy Returns

N99-189 TITLE: Small GPS Controlled Reception Pattern Antenna for Aircraft

N99-190 TITLE: Expendable Broadband Projectors for Undersea Warfare

N99-191 TITLE: Compact Mid-Infrared Laser for IRCM

N99-192 TITLE: EO/IR Sensor Applications on Supersonic Vehicles

N99-193 TITLE: GPS Ground Plane Nulling Antenna

N99-194 TITLE: Low Cost GPS Oscillator

N99-195 TITLE: Real-Time Pattern Recognition Algorithms for High Density Commercial and Military Applications

N99-196 TITLE: Geometric Patterning of Radar Absorptive and Reflective Materials (RARM) and Selective Combining of RARM materials to Achieve Improved Electromagnetic Interference (EMI) Protection and Significantly Reduced Radar Cross Sections (RCS)

N99-197 TITLE: Handheld Remote Fuel Quality Sensor

N99-198 TITLE: Ray-tracing Tool for directly interrogating Pro-Engineer Geometry

N99-199 TITLE: Real Time Motion Capture for Virtual Reality

N99-200 TITLE: Non-Lethal Clearing Facilities of Personnel

N99-201 TITLE: Armored Vehicle Internal Noise Reduction System

N99-202 TITLE: Remote Meteorological Sensor Package

N99-203 TITLE: Fiber Optic Multi-pin Connector for Towed Arrays

N99-204 TITLE: Water Based Hydraulic System

N99-205 TITLE: Search and Rescue (SAR) Using Active Light Detections and Ranging (lidar) Technology

N99-206 TITLE: Fault Diagnostics For Waterfront Construction

N99-207 TITLE: Scriptable Human Animation Figures in an Open Environmental Framework

N99-208 TITLE: Lightweight and Inexpensive Rigid Construction Paneling Material

N99-209 TITLE: Constructed Wetland System for Treatment of Washrack Effluent

N99-210 TITLE: Carbon Composite Reinforcement For Concrete Waterfront Construction

N99-211 TITLE: Automated Electromagnetic Optimization for Advanced Antenna Design

N99-212 TITLE: SMART Damage Control Boundary Opening System

N99-213 TITLE: Non-Cooperative Moving Target Recognition Using ISAR

N99-214 TITLE: Maritime Intelligence, Surveillance, Reconnaissance (ISR) and Space Exploitation

N99-215 TITLE: Pressure-Tolerant Batteries for Undersea Applications

N99-216 TITLE: Improve the Performance and Reduce the Cost of Central Components of Ocean Sampling Systems

N99-217 TITLE: Identification of Shallow Water Acoustic Environmental Parameters

N99-218 TITLE: Simulation Based Acquisition Development Environment

N99-219 TITLE: In-Situ Device for the Measurement of Gas in Shallow Sea Floor Sediments

N99-220 TITLE: Bright Ultra-cold Positron Beam Source for Chemical and Materials Analysis

N99-221 TITLE: Extended Torso Garment for Tactile Transduction

N99-222 TITLE: Self Regenerating Controller for High Power Magnetostrictive Devices

N99-223 TITLE: Mine Blast Seat Attenuation System

N99-224 TITLE: Advanced Concepts for Hull Array Beamforming Technology

N99-174 TITLE: Develop Low-Weight/Low-Cost AC/DC Regulated Converter for V-22 Applications

TECHNOLOGY AREAS: Aerospace

OBJECTIVE: Demonstrate the advantages of novel power electronic and thermal designs in cost (less than $23K), weight (less than 30 lbs.), reliability (2 time increase in mean time between failure(MTBF)) and performance improvements for AC/DC regulated converter applications for V-22 electrical power distribution system.

DESCRIPTION: Three regulated converters (CVs) are installed on the V-22 aircraft. The CVs convert aircraft 115/200 VAC, 360-457 Hz, 3-phase power into a regulated 28.7 +/-0.3 VDC output. The CV also control, protect and monitor the DC system which includes charging the main aircraft battery and configuring the system's seven contactors and one remote controlled circuit breaker. The CVs are rated at 200 amps DC continuous; provide up to 450 amps following a 9 kW power curve for transient overloads and fault clearing conditions; and provide up to 450 amps for auxiliary power unit (APU) starting following a minimum 6 kW power curve (and maximum of 10 KVA input during APU start). An innovative design will be required to meet the 30-lb maximum weight while achieving the stringent power quality, electromagnetic interference (EMI) and thermal requirements for an aerospace application. The power quality requirements are defined in MIL-STD-704D (30 Sep 80), titled, "Aircraft Electric Power Characteristics." The EMI requirements are defined in MIL-STD-461B (01 Apr 80) and MIL-STD-462. Their respective titles are "Electromagnetic Emission and Susceptibility Requirements for the Control of Electromagnetic Interference" and "Electromagnetic Interference Characteristics, Measurement of." Thermally, the CV should operate its components in safe operating temperatures for a high reliable and long life operation (MTBF 6,000 hrs) at altitudes from sea level to 30,000 feet and at temperature extremes from +71°C maximum to -54°C minimum. The APU start function is required only up to 17,500 feet. Innovative thermal technologies may be considered. However, the aircraft ECS system will provide cooling air. The total pressure drop through the CV should not be greater than 1.0 inches of water when furnished with its minimum air mass flow rate of 7.0 lbs./min at an inlet temperature of 55°C and at an ambient pressure of 14.7 psia. All other operating temperatures and pressures will correspondingly scale the mass flow rate. The CV efficiency should be greater than 70% at 25 amps DC output; 80% from 100 to 300 amps DC output; and 65% at 450 amps DC output. The size of the CV is not to exceed the requirements stated in the Bell Boeing Envelope Drawing 901-375-201. The procurement cost requirement of less than $23K is for a production CV that meets all V-22 military qualification requirements including shock, vibration, temperature altitude, environmental and explosive atmosphere. Specific requirements are defined in Bell Boeing Report No. 901-375-738 Revision LTR G.

PHASE I: Conduct a feasibility study that defines the design required to meet the objectives for weight, reliability, production cost and electrical performance. This study must include potential commercial applications for this converter. Simulations and/or breadboard testing of electrical and thermal solutions may be used if required for tradeoff purposes. If the goals cannot be met, the feasibility study effort must identify research areas needed to accomplish the goal in Phase II.

PHASE II: Develop, test, and operationally demonstrate the regulated CV designed under the Phase I effort. The demonstration shall demonstrate all modes of electrical operation including the CV's ability to control, protect and monitor the DC system. This also includes charging the main aircraft battery and configuring the system's contactors. Output signal loads (i.e., contactor relays and logic status) may be simulated for demonstration purposes. Performance evaluation should also include EMI testing at an accredited laboratory. The EMI tests should be CEO3 and RE02. The unit should be fabricated for demonstration purposes and is not be required to be tested for shock and vibration. The design analysis effort should address all CV military specification requirements, be provided in the engineering analysis and documented in the final report, even though the CV will not be tested to all requirements. The unit should also be thermally tested varying temperature and mass airflow rates to evaluate potential innovative thermal solutions.

PHASE III: Produce the hardware developed under Phase II and evaluate in Boeing's system level bench test. Perform qualification development and safety-of-flight qualification testing, then install and flight-test on V-22 aircraft.

COMMERCIAL POTENTIAL: The commercial airlines would benefit from a regulated power supply that has a power density (kW/lb.) 34% higher and costs less than today's V-22 converter.

REFERENCES: MIL-STD-461B MIL-STD-462 MIL-STD-704D

N99-175 TITLE: Failure Detection System for Composite Joints

TECHNOLOGY AREAS: Aerospace, Materials, Surface

OBJECTIVE: Develop a portable, non-contact digital system for detecting failure initiation and propagation, and load intensity in structural composite joints in real time.

DESCRIPTION: The total ownership cost for air vehicles, both manned and unmanned (including weapons) can be reduced if the structural components have lower weight, improved structural integrity, and lower parts count. This can be accomplished by utilizing fiber- reinforced composite bonded joints and joints with woven inserts in the design and manufacture of the structural components. Efficient and reliable design of composite bonded joints requires thorough understanding of failure (e.g. delamination, fiber breakage) mechanisms and bond strength. Composite joints can only be used if we can predict the failure initiation and propagation and load intensity in the joints in real time. Tools are needed for validating the predicted results and developing the most efficient and reliable composite joints.

For example, in highly loaded composite structures, failure may start at several places simultaneously. X-rays can provide visualization of the whole field, and can be used to locate several failure locations simultaneously. This experimental information is of great value for developing optimized composite structures. The portable, non-contact digital X-ray system can be used to design and develop efficient structural composite joints. With proper modifications and calibration, it can also be used for damage assessment, inspection, and corrosion detection on carriers, in depots, and in the field. The technology will also have potential use for the medical field, airport security, and detecting illegal drugs.

PHASE I: Perform a feasibility study for detecting (2D and 3D) failure (e.g., delamination, fiber breakage) initiation and propagation, and load intensity at failure locations in representative test specimens in real time. The specimens should be fiber-reinforced composite lap joints and joints with woven inserts. The system should be portable, have spatial resolution of the order of 15 line pairs per millimeter, contrast sensitivity of the order of 0.2%, and make no contact with the specimens. The maximum size of the specimens could be 10 inches in diameter and 6 inches thick, and the speed of scanning should be at least 1 second per scan for two dimensional scanning and 8 second per scan for three dimensional scanning.

PHASE II: Based on the feasibility study in Phase I, develop a portable system with appropriate software, and perform extensive tests on various composite lap joints and joints with woven inserts. The testing should document digitally (2D and 3D) the failure initiation and propagation and load intensity at failure locations in the specimens. The test data will be utilized to validate the failure analyses by government/industry laboratory personnel. The system should also have the capability for damage assessment and inspection on carriers, in depots, and in the field.

PHASE III: Transition the technology to the government and commercial communities for structural damage assessments, corrosion detection, and nonmetallic, polymeric and organic material identification.

COMMERCIAL POTENTIAL: The proposed system could be used for airport security, medical applications, corrosion detection in offshore pipelines, and identifying illegal drug identification.

KEYWORDS: Composites; Bonded; Joints; Woven; Inserts; Failure; Damage; Inspection; Digital

N99-176 TITLE: Selective Depainting and Precision Cleaning

TECHNOLOGY AREAS: Aerospace, Materials

OBJECTIVE: To develop a capability for the selective depainting of Navy aircraft and to clean precision instruments and equipment.

DESCRIPTION: Recent advances in ultrasonic technology show significant promise for depainting, and cleaning critical equipment using non-hazardous materials. All of this occurs without any damage to the underlying substrate. Navy aircraft finishing systems for aluminum consist of an inorganic surface pretreatment (chromated, conforming to MIL-C-81706) followed by a series of organic coatings: primer (conforming to MIL-P-23377 or MIL-P-85582) and topcoat (conforming to MIL-PRF-85285). The surface pretreatment enhances corrosion inhibition and adhesion to the primer. The primer contains additional corrosion inhibitors and provides an adhesion layer for the topcoat. The topcoat provides chemical and weather resistance, as well as flexibility and the required optical properties. Currently, there is a need for an environmentally friendly method for the selective depainting of aircraft to remove the 10-15% of paint remaining after the use of flash jet and other technologies. Such a method has a second potential application for the precision cleaning of gyroscopes, bearings, and other components without the need for volatile solvents or hazardous chemicals.

PHASE I: Demonstrate depainting and precision cleaning in a laboratory setting. Design a system to scale up the process for rapid depainting of various types of paints on common aircraft surfaces. Estimate the speed of depainting based on results. Explore a method for precision cleaning of aircraft and crew systems equipment.

PHASE II: Build and test a prototype system and conduct full-scale tests to demonstrate the feasibility for depainting or cleaning Navy aircraft and equipment. Conduct full-scale precision cleaning tests for applications identified in Phase I.

PHASE III: Customize and implement the Phase II work for appropriate Navy aircraft and ship programs and for commercial aircraft.

COMMERCIAL POTENTIAL: An efficient, environmentally friendly method for de-painting has applications to commercial aircraft as well as to both Navy and commercial ships, engines and manufacturing equipment. Applications in cleaning include industrial, medical and commercial applications where removal of contaminates on critical surfaces or life support equipment is needed. The transition should occur rapidly after the process is validated for Navy aircraft and ships.

REFERENCES: 1. SAE MA4872 2. MIL-C-81706 3. MIL-P-23377 4. MIL-P-85582 5. MIL-PRF-85285

KEYWORDS: Environmentally Friendly; Depainting; Selective; Precision Cleaning

N99-177 TITLE: Innovative Protective Coating Systems for Aircraft

TECHNOLOGY AREAS: Aerospace, Materials

OBJECTIVE: Find a single-component, protective coating system for use over aircraft surfaces which does not require pretreatment, a primer, and/or a topcoat. The technology shall meet the performance requirements of TT-P-2756, MIL-P-23377, MIL-P-85582, MIL-PRF-85285, and AMS 3603.

DESCRIPTION: Currently, the Navy aircraft finishing systems for aluminum consist of an inorganic surface pretreatment (chromated, conforming to MIL-C-81706) followed by a series of organic coatings: primer (conforming to MIL-P-23377 or MIL-P-85582) and topcoat (conforming to MIL-PRF-85285). The surface pretreatment enhances corrosion inhibition and adhesion to the primer. The primer contains additional corrosion inhibitors and provides an adhesion layer for the topcoat. The topcoat provides chemical and weather resistance, as well as flexibility and the required optical properties. Although this finishing system has been the premiere finishing system on aircraft for many years, it has several deficiencies. An increased awareness and concern for environmental issues as well as worker safety have caused local, state, and federal agencies to limit volatile organic compound (VOC) and hazardous air pollutant (HAP) emissions. The majority of these corrosion inhibitors found in pretreatments and primers are hexavalent chromates and have been identified as human carcinogens. VOCs have been attributed to the production of ground-level ozone and smog. The Navy wants to develop an environmentally friendly, single-component coating system.

PHASE I: Provide an initial development effort that combines nontoxic corrosion inhibitors with a binder system to produce a single-component coating for use on Navy aircraft. The coating must meet the current military and performance specifications as well as be compatible with existing materials. Additionally, the application of the proposed coating should not interfere with the logistical and operational requirements of the naval facility tasked to use the coating.

PHASE II: Refine, test, and field demonstrate the coating developed under the Phase I effort.

PHASE III: Produce the coating demonstrated in the Phase II effort. The coating will be transitioned to the Fleet through specification modifications and revisions to aircraft weapons system technical manuals. If further development and/or field-testing are require, aircraft programs funding or W2210 funds will be pursued.

COMMERCIAL POTENTIAL: A non-hazardous, single-component coating system can be used on commercial aircraft as well as non-aerospace applications for both the government and private sector, making this technology directly transferable.

REFERENCES: 1. MIL-C-81706 2. MIL-P-23377 3. MIL-P-85582 4. MIL-PRF-85285 5. TT-P-2756 6. AMS 3606

KEYWORDS: Environmentally Friendly; Coating System; Single Component; Pretreatment; Primer; Topcoat

N99-178 TITLE: Non-Chromated Flexible Primer

TECHNOLOGY AREAS: Aerospace, Materials

OBJECTIVE: Develop a primer for aircraft applications that contains no chromated corrosion inhibitors and exhibits exceptional flexibility.

DESCRIPTION: The Navy and the Air Force currently use a flexible primer as the primary component of the corrosion-prevention finishing system on various aircraft (e.g. E-2/C-2, H-53, large cargo aircraft). This step is necessary to prevent film cracking at low temperatures (-60°F) and subsequent corrosion primarily at high-flexing components and fastener patterns. The current flexible primer contains chromated corrosion inhibitors; these compounds have been identified as carcinogens and elimination of their use has been mandated at all levels of government, especially in southern California. This is particularly crucial because most Navy rework involving high-flexing aircraft is performed at the Naval Air Depot, North Island, which is located near San Diego.

PHASE I: Provide an initial development effort that incorporates nontoxic corrosion inhibitors into a polymeric binder system to produce a sprayable, flexible coating for use on Navy aircraft. The coating must meet the current military specification as well as be compatible with existing pretreatments and topcoats. Additionally, the application of the proposed coating should not interfere with the logistical and operational requirements of the naval facility tasked to use the coating.

PHASE II: Develop, test, and field demonstrate the coating formulated under the Phase I effort.

PHASE III: Produce the coating demonstrated in the Phase II effort. The coating will be transitioned to the Fleet through specification modifications and revisions to the aircraft weapons system technical manuals. If further development and/or field-testing are required, aircraft program funding or demonstration programs funds will be pursued.

COMMERCIAL POTENTIAL: Successful coating can be used on commercial aircraft as well as on other DOD aircraft.

REFERENCES: 1. TT-P-2760 2. MIL-C-85285 3. MIL-C-81706/5541 4. TT-P-2756

KEYWORDS: Primer; Coating; Non-Toxic; Chromates; Flexible

N99-179 TITLE: Innovative Thermal Barrier Technology for Exterior Aircraft Structures

TECHNOLOGY AREAS: Aerospace, Materials

OBJECTIVE: Develop a thermal barrier technology that can easily be applied to exterior aircraft structures. The technology should prevent premature hardware failure due to localized overheating and should meet a thermal insulation requirement for target applications. The technology insulation requirement is aircraft dependent, with potential short-term thermal excursions as high as 800°F (60 seconds), and long-term exposure at 285°F (duration of flight). Depending on substrate materials, the substrate operation time could be as high as 325°F or as low as 200°F.

DESCRIPTION: During certain flight and/or ground operations on several types of aircraft, exterior structures and components are exposed to engine exhaust. These structures and components were not designed for these errant non-flight profile cyclic temperature profiles. As a result they are in need of premature repair or replacement. A thermal barrier technology composed of environmentally responsible materials with low toxicity is sought for protection from transient temperature excursions. Furthermore, a thermal barrier technology that is easy to apply and remove at both field and depot level is needed to minimize heat conduction. The developed protection system must not inhibit the use of standard depot nondestructive inspection techniques for evaluating the integrity of the underlying substrate.

PHASE I: Develop a thermal barrier protection concept that can be applied to the exterior surfaces of aircraft and withstand the dynamics of airflow during typical flight operations. Zero volatile organic compounds (VOC) emitter, non-organic hazardous air pollutant (HAPS) and single-component should be target properties of the thermal barrier protective coating. In addition, the coating should have an ambient temperature cure and storage (not mandatory). The technology's thermal conductivity properties should be defined. In addition this technology should meet VOC content limits as established by NESHAP (National Emissions Standards for Hazardous Air Pollutants) regulations. The fluid resistance, humidity resistance, adherence properties and flexibility must meet the performance requirements of AMS 3603, MIL-PRF-85285, and/or TT-P-2756. Preliminary laboratory testing will demonstrate the feasibility of this technology as thermal protection for its target application (exterior aircraft structures and components).

PHASE II: Further develop the technology to meet the objectives of the Phase I results and conduct laboratory testing to further characterize the properties of the materials. The laboratory testing will provide adhesion characteristics, thermal conductivity, hot/wet thermal cycling, nondestructive inspection characteristics, and failure mode characteristics. If possible, conduct flight testing of the material on an aircraft.

PHASE III: Production of the technology demonstrated in Phase II of this effort should be demonstrated and studied for both the military and commercial markets. If further development and/or field-testing are required, aircraft program or demonstration program funds will be pursued.

COMMERCIAL POTENTIAL: This technology can be transitioned to commercial aircraft as well as non-aerospace applications for both the government and private sectors.

REFERENCES: 1. AMS 3603 2. MIL-PRF-85285 3. TT-P-2756.

KEYWORDS: Thermal Barrier; Thermal Insulation; Aircraft Surfaces

N99-180 TITLE: Design Assistant and Software Tools for System Identification and Adaptive Fault-Tolerant Control

TECHNOLOGY AREAS: Aerospace, Computing, Electronics, Modeling

OBJECTIVE: : Enhance the maneuverability and survivability of aircraft under adverse conditions such as battle damage and critical system failures using on-line system identification (SI), Health Monitoring and Failure Detection and Identification (HM-FDI), and Adaptive Fault-Tolerant Control (AFTC)

DESCRIPTION: Future combat aircraft will be expected to operate outside currently achievable flight envelopes and achieve desired flying qualities in the presence of large uncertainty, severe subsystem failures, battle damage and large unanticipated disturbances. In addition, the dynamics of the aircraft under aggressive maneuvers are highly nonlinear. While some results related to aircraft HM-FDI, disturbance estimation and rejection, AFTC and structure and parameter estimation using efficient SI techniques are available in the existing literature, many of the important related problems have not been addressed. These include:

1. How to determine the sensitivity of the overall closed-loop system to different failures and disturbances?
2. How to model and parameterize different types of failures and structural damage?
3. How to relate the available redundancy to failure accommodation and disturbance compensation?
4. How to address the problem of severe single and multiple failures that cannot be handled using existing methods?
5. How to achieve fast and accurate on-line identification of aircraft flutter and rigid body modes and uncertain aircraft parameters?
6. How to effectively combine the on-line nonlinear SI techniques with HM-FDI and robust controllers to arrive at a highly efficient AFTC system for failure accommodation and flutter suppression?

In addition, a software tool is needed to aid the flight control designers in the design of HM-FDI, AFTC systems and SI techniques.

PHASE I: Design integrated HM-FDI and AFTC algorithms for an aircraft model under battle damage, sensor/actuator failure conditions, and parametric uncertainties. Demonstrate the viability of the algorithms and stability, robustness and performance of the overall closed-loop system. Test adaptive fault-tolerant controllers on an aircraft model for different critical maneuvers under failures and parametric uncertainties. Design new and unique SI techniques for fast and accurate on-line estimation of flutter and rigid body modes and uncertain aircraft parameters. Develop a conceptual solution for the HM-FDI and AFTC design toolbox.

PHASE II: Demonstrate the features of the software tool using hardware-in-the-loop simulations. Carry out further validation, including in-flight testing, of the SI, HM-FDI and AFTC software.

PHASE III: Apply tool box to solve Navy aircraft fleet problems or aircraft performance enhancement. Demonstrate this improved design through simulation and then flight test. The flight test demonstration for a high-performance aircraft will be accomplished using the research flight control computer developed for the F-18 ABCD aircraft (fleet support flight control computer (FSFCC)). Incorporate tool box into commercial software for use by automotive industry, commercial aircraft companies, biotechnology industries, etc.

COMMERCIAL POTENTIAL: The toolbox could be incorporated into commercial software for use by automotive industry, commercial aircraft companies, biotechnology industries, etc.

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3. M. Anderson, "Robustness Evaluation of a Flexible Aircraft Control System", Journal of Guidance, Control & Dynamics, Vol. 16, No. 3, pp. 564-571, May-June 1993.
4. S. N. Balakrishnan and V. Biega, "Adaptive-Critical-Based Neural Networks for Aircraft Optimal Control" Journal of Guidance, Control & Dynamics, Vol. 19, No. 4, pp. 893-898, July-August 1996.
5. M. Bodson and J. Groszkiewicz, "Multivariable Adaptive Algorithms for Reconfigurable Flight Control", IEEE Transactions on Control systems Technology , Vol. 5, No. 2, pp. 217-229, Mar 1997.
6. J. D. Boskovic, "A Multiple Model-Based Controller for Nonlinearly-Parametrized Plants", in Proceedings of the American Control Conference, Vol. 3, pp. 2140-2144, Albuquerque, NM, June 1997.

KEYWORDS: Adaptive Control; Health Monitoring; Failure Detection; Failure Identification; Adaptive Fault-Tolerant Control and System Identification

N99-181 TITLE: Weight Efficient Corrosion Resistant Composite Heat Exchangers

TECHNOLOGY AREAS: Materials

OBJECTIVE: Develop a weight efficient composite heat exchanger for the V-22, capable of withstanding a high temperature, corrosive environment.

DESCRIPTION: The Navy has an immediate need for an alternative to the metallic Environmental Control System (ECS) primary and secondary heat exchangers currently being utilized on the V-22. The primary and secondary heat exchangers cool high temperature air that is the power source for the ECS. These components, which are fabricated from an aluminum alloy, are similar in construction to many other aircraft ECS heat exchangers. The operational conditions for the V- 22 require that the hot side inlet on the primary heat exchanger be capable of withstanding a maximum temperature of 525 degrees F, where the mass flow is 40 lbs/min at 51 psia. The corresponding conditions at the cold side of the primary heat exchanger include a temperature of 215 degrees F and a 72 lbs/min mass flow at 14.9 psia. The existing metallic designs are weight inefficient, and may be prone to oxidation and corrosion degradation. Metallic heat exchangers utilized on other aircraft, such as the F-18, have a long history of corrosion and oxidation related problems. The unique requirement that Navy aircraft operate in a salt prone environment compounds these issues. The environment induced damage mechanisms have led to reductions in the life expectancy of the heat exchanger components, and resulted in significant fleet maintenance burdens. The end result is an increase in life-cycle costs associated with the aircraft. Advanced high-temperature composite materials such as carbon-carbon and ceramic matrix composites (CMC's) may provide the necessary solution for the life extension of these components. Carbon-carbon has been demonstrated to withstand a high-temperature environment and can be designed to exhibit a high thermal conductivity. CMC's, although typically thought of as insulators, may provide higher resistance to oxidation and a corrosive environment.

PHASE I: Demonstrate feasibility by designing, fabricating, and testing prototype composite sub elements representative of a V-22 primary or secondary heat exchanger. Provide preliminary data, which indicates the ability of the design to withstand the harsh environment. Analytically show that the proposed concept provides the required thermal performance and meets the structural requirements as well.

PHASE II: Develop the detailed design of a complete V-22 primary or secondary heat exchanger, including attachment concepts and fabrication methods. Demonstrate produceability by fabricating a full scale V-22 primary or secondary heat exchanger. Demonstrate the ability of the design to withstand the hot corrosive and oxidation environment. Evaluate the performance of the component under realistic simulated flight conditions.

PHASE III: Utilize the developed V-22 heat exchanger design and fabrication methods to transition the technology to other aircraft and other heat exchanger configurations.

COMMERCIAL POTENTIAL: Advanced composite heat exchanger components have the potential to transition to the commercial aircraft market for weight reduction and enhanced life expectancy.

KEYWORDS: Heat Exchanger; V-22; Composite Materials; Carbon-Carbon; Ceramic Matrix Composites

N99-182 TITLE: Low Cost Turbojet Engine for Expendable Target Applications

TECHNOLOGY AREAS: Aerospace

OBJECTIVE: The US Navy is interested in exploring the potential of low cost turbojets to fulfill the propulsion requirements of future aircraft target systems. Current radio controlled (RC) hobby aircraft use inexpensive turbojet engines that generate up to 40 pounds of static thrust, which is less than our envisioned future requirements.

DESCRIPTION: We are interested in either new engines using current hobby engine technology or increasing current hobby engine performance >160 pounds of maximum static thrust, or the simultaneous use of two engines generating >80 pound of static thrust each. These engines will be expected to operate in target aircraft that operate in a salt air environment. Target flights do not typically exceed 60 minutes, operate for a maximum of five flights, and use JP-5/JP-8 fuel during these flights. They should start by use of compressed air into the engine's compressor to reach a minimum self-sustaining operating RPM, and should provide maximum thrust, without degradation, over the expected life of 200 minutes. The cost goal for each target propulsion system is <$10,000.00 (in current 1998 dollars) in production runs of not less than 200-250 engines.

PHASE I: Provide an in-depth study characterizing current RC aircraft turbojet performance (thrust, fuel consumption, operating temperatures), along with a detailed design study of potential changes and improvements that meet both the performance and cost objectives listed above.

PHASE II: Execute an engine modification, or prototype production program for selected engines, utilizing the design study of Phase I. Perform sea level performance and reliability/durability testing on these engines to demonstrate minimum performance based upon Phase I projections.

PHASE III: Provide production representative engines to airframe manufacturers for low cost target program.

COMMERCIAL POTENTIAL: Success through Phase III will provide hardware that could be modified for turboshaft and turbofan applications for both civil aviation and ground applications (gen-sets, automotive, etc)

KEYWORDS: Turbojet; Target

N99-183 TITLE: Motion Coupling in a Deployable Virtual Environment Trainer

TECHNOLOGY AREAS: Human Systems, Manpower, Modeling

OBJECTIVE: Develop strategies and methods for linking real-world motion with perception in a virtual environment

DESCRIPTION: The military's vision of deployable training systems introduces a novel problem for application of virtual environments (VE) in these settings. Cybersickness, a type of motion sickness particular to immersion in a VE, is produced by discordance between the perception of motion in the VE and lack of actual motion. A deployed VE trainer would have the additional difficulty of having actual motion discordant with VE perceived motion (rather than a lack of motion). This could substantially limit the usefulness of deployed VE trainers. One possible method of combating this perceptual discordance is to include the actual real-world motion in the VE. This would require motion information from the deployed platform (such as a ship or aircraft) to be transmitted to and incorporated in the virtual environment. This could be especially useful for tasks in which the actual motion is a true part of the task (such as for a conning officer or landing signals officer).

PHASE I: Identify and develop methods and techniques to effectively couple actual motion with perceived VE motion. Hardware and software requirements will be defined and established with consideration given to potential deployment platforms (such as ships) and human performance requirements (such as lag time).

PHASE II: Implement the design requirements identified in phase I in a test bed for an identified Navy application.

PHASE III: Based on a successful Phase II effort, refine the test bed into a product suitable for commercial and military applications.

COMMERCIAL POTENTIAL: This technology would enable effective use of virtual environments on any moving platform (such as ships, aircraft, hovercraft, land transportation, etc.).

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KEYWORDS: Virtual Reality; Training; Motion Simulation; Simulation; Cybersickness; Motion Sickness

N99-184 TITLE: Alternate Time Management Schemes for Use in High Level Architecture (HLA) Federate Simulation

TECHNOLOGY AREAS: Manpower

OBJECTIVE: Enabling joint force exercises to occur through the linking of military training simulators would reduce the operation and maintenance costs of the weapons systems involved by at least an assumed 20 to 30 percent. Specifically, this topic seeks to develop software architecture capable of interfacing with federated simulations to demonstrate timing and latency compliance in a jointly scripted mission scenario. The architectural model for processing simulation data transfer messages will be in accordance with the federate and object templates and HLA compliance rules. To the maximum extent feasible, the solution should be based upon the utilization of standardized components, such as the management object model (MOM), data interchange format (DIF), and data dictionary (DD), rather than customized extension solutions.

DESCRIPTION: The Navy is vigorously increasing its use of modeling and simulation to improve war fighting skills in a peacetime environment and to develop superior capable weapon systems. To this end, the DOD initiative establishing HLA simulation has directed the Services to guarantee inter-operability of federated simulation models and allow reusability based upon both common interfacing and separation of message data handling from object model functionality. Thus the system models developed can provide federated mission oriented training capability with the required fidelity to train crews in a total tactical environment. This will involve networking of joint simulations including full man-in-the-loop aircraft simulators configured for mission scenario training such as Navy: F-14; F-18; E-2; EA-6; Air Force: USN CV; F-22; F-16; USAF conventional takeoff and landing (CTOL); Marine Corps: F/A-18; AV-8B; STOVL; in joint strike scenario tactics. Present aircraft simulators do not support mission synthetic training because no provision enables the inter-operability required for networking that does not follow a common message protocol. Although distributed interactive systems (DIS) provided such a common protocol at a message broadcast rate, large bandwidth requirements often resulted in data latency. In contrast to DIS interface standards, HLA allows for a choice of interface time management schemes for message traffic between federated simulation models that may reduce bandwidth requirements. In order to implement interpretable federates with compatible message transfer which minimize delay or latency in tactical event timing, a time management scheme must be chosen which complements the data transfer requirements. HLA has a mechanism in place that is well suited for addressing this sort of thing -- MOM. In addition to the MOM, there are other standards, or standard pending mechanisms, that can be of use in this area of research. These mechanisms include DIFs and the DD under development by the Defense Management and Simulation Office (DMSO). However, many of those who have looked at event/timing management, have implemented solutions based upon their own customized federation object model (FOM) extensions. Rather than develop another customized FOM extension solution, perhaps a more desirable approach (more conducive to generic inter-operability) is to implement a solution that is based upon utilization of standardized components, such as the MOM, DIFs, and DD, to the maximum feasible extent. A study is needed of the mission training message data requirements and their impact upon message transfer rates and upon the simulation message processing architecture and data base design. Alternate message architecture and timing management must be investigated to provide the basis for selection of schemes meeting federate requirements.

PHASE I: Investigate mission federate data transfer requirements in the context of scenario events and options and the alternate message time management schemes that might meet data transfer and latency requirements. The project must investigate use of filtering schemes (using MOM or DDM). Also, Naval Air Warfare Center, Training Systems Division in-house developed software, Simulation and Modeling Object Classes/Common Interoperability Mechanism (SMOC/CIM) should be included in the Phase I review. A conceptual, message timing and processing architecture will be postulated and mapped to a software structure. It is expected that problem areas identified in the literature would be identified and documented for inclusion in the Phase II effort. PHASE II: Implement the message timing management scheme by prototyping the architecture software and interfacing with federated simulations for demonstration of timing and latency compliance in a jointly scripted mission scenario; i.e., implement a filtering using MOM, DIFs, DD, or even DDM. The architectural model for processing simulation data transfer messages will be described in accord with the federate and object templates and HLA compliance rules. Research into how different time management schemes could be used within a single federation or how the protocols could be designed to accommodate different simulation types but merge to a single time management scheme should also be conducted.

PHASE III: A transition filtering scheme to a naval simulation would be made to include naval surface simulation, Army and Marine Corps simulated ground forces and helicopter support, and command and control simulations. Commercial transitions are anticipated to occur as well.

COMMERCIAL POTENTIAL: FOMs can be written for a wide variety of applications far beyond the military's simulated weapons platform interactions. For example, the HLA message timing management scheme could enable logisticians to assess the impact of new support models on an existing (simulated) delivery system faster than real time. Accountants may wish to test the effects of new cost models on a simulation-based acquisition process. Manufacturers designing new plants could have their assembly-line designs tested and analyzed by adding suppliers' virtual models of sub-assembly stations and robotic concepts to their virtual assembly-line prototype model. Moreover, with a standardized architectural model for processing simulation data transfer messages, it is possible that any of the models just described could be combined as needed for any number of yet-to-be identified simulated tests.

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KEYWORDS: High Level Architecture; Federated Simulation Models; Federation Object Model, Simulation, Modeling, DIS.

N99-185 TITLE: Client/Server Part Task Trainer Interface

TECHNOLOGY AREAS: Manpower

OBJECTIVE: Develop a client/server interface and supporting client and server software to enable a helicopter part task trainer (PTT) emulation to function in a standalone or in an internet server interactive training mode. Develop server and distributed embedded client PTT software to enable bi-directional synchronous and asynchronous data transfer over the Internet. These Internet data transfers will enable server administrative management of single or multiple remote site PTTs concurrently. This capability sequentially leads the way for aircraft representative collaborative training for military aircrews, synthetic warfare, and commercial aircraft operations.

DESCRIPTION: The Navy has fielded multiple helicopters PTTs that emulate a variety of aircrew control display units (CDUs). These CDU emulations (CDUEs) reflect unique operational flight program (OFP) functionality for specific types of aircraft. Several Navy helicopters use common CDU hardware; however, some use unique CDU hardware with a unique faceplate design and a unique OFP (e.g., AH-1W Cobra helicopter). The mission functionality in each CDU (common or not) is unique to each aircraft platform, and is representative of the implemented hardware and the resident OFP. However, the objective of each CDUE is common - to provide aircrew training using an aircraft representative man/machine interface. Current PTTs that host CDUEs are stand-alone systems under full control of the trainee. Training objectives that cannot be met with a stand-alone PTT include instructor initiated fault insertion, and interactive training operations with remote site users in a common theater of operation (collaborative training). Expanding CDUE functionality to enable server connectivity with an embedded data transfer interface is required. This distributed CDUE environment will support incremental expansion of mission training in a multi-aircraft environment.

PHASE I: Conduct in-depth analysis and provide proof of concept that a CDUE can host and support an embedded network communication application in a client/server mode transparent to the user. This interface must provide scheduled and unscheduled CDUE-to-server and server-to-CDUE data transfers in a background mode. The aircrew interface must remain aircraft representative during all modes of training operations.

PHASE II: Continue with the concept developed in Phase I and develop a prototype system. Demonstrate the operation and feasibility of using multiple CDUEs to perform collaborative mission functions (e.g., establish single-channel ground airborne radio system (SINCGARS) link between two aircraft) and server initiated fault insertion.

PHASE III: Produce PTT and server software applications that comprise an embedded client/server interactive PTT system. This interactive system will be the basis for further development and production of PTT systems for all Navy aircraft.

COMMERCIAL POTENTIAL: Avionics similar to the CDU are utilized in a variety of commercial aircraft. As the FAA approaches implementation of "Free Flight", collaborative multi-aircraft aircrew training requirements will increase as aircraft traffic management transitions from ground based controllers to aircraft avionics control. Commercial aircrew training systems will share the same cost savings advantages as DoD with the fielding of this system. Training for collaborative processes or procedures is seen to capitalize on the technology implemented in this system.

REFERENCES:
(1) AH-1W Cobra 1A Human Interface Document
(2) AH-1W Cobra 1A Functional Requirements Document
(3) AH-1W Cobra 1A System Specification.

KEYWORDS: PTT; CDU; Server Client Interface; Interactive Collaborative Training; Internet

N99-186 TITLE: Shallow Water Directional Noise Measurement Sensors

TECHNOLOGY AREAS: Battlespace, Environmental, Sensors, Modeling

OBJECTIVE: Develop and fabricate a sensor to measure the directional noise and reverberation characteristics for active systems in shallow water ocean areas.

DESCRIPTION: Active sonar detection and classification systems require detailed knowledge of the background noise and reverberation field in order to operate effectively. Knowledge of the reverberation direction and amplitude is important in selecting sonar transmitter parameters, setting receiver beamwidths and steering angles, and establishing sonar deployment geometry. Currently, only limited background noise directionality is attainable with on-board or expendable measurement sensors. Current environmental acoustic sensors only measure parameters for passive acousitc systems such as temperature versus depth and ambient noise. New technology will develop new innovative ways to measure environmental acoustic parameters applicable to both active and passive system performance such as monostatic and bistatic reverberation. Other required performance prediction parameters can be derived from this such as bottom backscatter, bottom depth, and bottom loss. These parameters are critical to the performance of active acoustic systems operating in littoral environments. An innovative approach that incorporates new technologies to affordably measure both passive and active environmental acoustic parameters using one multi-parameter device. It will also measure the directional noise and reverberation field in-situ. Emphasis should be placed on a compact, affordable automatic measurement sensor capable of being used in expendable air deployed measurement devices. It is anticipated that the sensor will require a sound source, receiving array, and processing algorithms within the device. The sensor should be capable of operating at frequencies below 1000 Hz but as a goal be capable of operating between 50 Hz and 10 kHz. The sensor must survive the shock, vibration, and temperature environments of an air deployed device, and be capable of providing both monostatic and bistatic directional measurements in water depths to 1000 ft. This sensor is intended to support performance predictions for Air ASW Tactical Acoustic Systems such as Improved Extended Echo Ranging (IEER) and Airborne Low Frequency Sonar (ALFS). A key technology would be to incorporate some type of Active Acoustic Probe Pulse using coherent or impulsive source technology (e.g. source sparkler technology may apply).

PHASE I: Develop a conceptual design for a directional noise measurement sensor that meets Navy needs. Include transducer elements, electronic interface circuitry, and processing algorithms that will implement the proposed concept. Also conduct a study to investigate the feasibility of integrating this sensor into an A-size sonobuoy configuration.

PHASE II: Develop detailed designs for the Phase I sensor design and fabricate a limited number of prototype sensors suitable for open ocean proof of concept testing. Conduct preliminary testing in a laboratory and in ocean shallow water environments and report the results of this preliminary testing to the Government.

PHASE III: The sensor, upon meeting Navy requirements, will be transitioned into the airborne sensor production program and/or into a multi-purpose environmental measurement probe program.

COMMERCIAL POTENTIAL: The directional noise sensor developed should have applicability to a variety of commercial needs as an environmental quality technology. These application would include investigations of marine mammal behavior and habitat changes due to increasing noise levels in the ocean environment. This device could also be used to monitor the level and direction of underwater noise caused by offshore oil exploration/drilling or other underwater commercial activities to assure compliance with EPA regulations.

REFERENCES: TAMDA (Tactical Acoustic Measurement and Decision Aid) Program, funded by CNO (N096) FY-99 to FY-01 and in CNO (N88) POM FY-02 to FY-07.

KEYWORDS: Active Sonar; Ocean Environment; Noise; Reverberation; Sensor; Expendables

N99-187 TITLE: High-Bandwidth Scene Projector Drive Electronics

TECHNOLOGY AREAS: Electronics, Electronic Warfare, Manpower, Sensors, Manufacturing

OBJECTIVE: Develop high-bandwidth scene projector electronics capable of providing signals to large area infrared emitter arrays (e.g., 1024x1024 pixels at rates up to 420 megabytes/sec (2 bytes per pixel)). High-bandwidth drive electronics will be incorporated into the Navy's Air Combat Effective Test and Evaluation Facility (ACETEF) for use in simulation/stimulation of integrated/installed EO/IR sensors and associated processing avionics.

DESCRIPTION: Technologies are needed to develop drive electronics to handle a throughput of approximately 420 megabytes/sec (2 bytes per pixel) to effectively evaluate current and future systems under test (SUTs). Significant innovation is required to solve the problem of data throughput. The high-bandwidth scene projector drive electronics will accommodate data processing functions at up to 420 megabytes/sec such as: (1) accept as input 16 bit pixels, (2) playback from local memory stored sequences, (3) perform 32 point linear interpolation per pixel non-uniformity correction, and (4) output scan conversion. Under this task, innovative approaches to fabricate and demonstrate high-bandwidth scene projector driver electronics will be developed. The electronics should be capable of supporting high-resolution infrared emitter arrays that perform projection at real-time rates. Cost reductions can be expected in: -More effective stress testing of IR sensor performance capability, thereby reducing the number of rescheduled open range test flights caused by sensor system malfunctions or performance deficiencies. - Providing pilot and operator training using wide field-of-view IR sensor simulations/stimulations that require high-bandwidth drive electronics. - Supporting sensor developers with the ability to test engineering and managing development (EMD) sensors under dynamic and accurate simulations/stimulations. - Providing aircrew with the ability to test the effectiveness of evasive tactics, thereby increasing safety of flight.

PHASE I: Produce a design for prototype high-bandwidth scene projector drive electronics capable of controlling government identified infrared emitter arrays (either existing or emerging technology) with emphasis on throughput, weight/volume, low noise, uniformity, and adaptability to a variety of emitter array types and formats. Design trades for optimizing throughput must also be shown.

PHASE II: Construct prototype high-bandwidth scene projector drive electronics and demonstrate control of several government furnished emitter arrays. Develop a graphical user interface (GUI) through which the user will have control of all functions of the drive electronics. The GUI must be hosted on either an NT or UNIX platform. Electrically interface the prototype electronics with existing Navy image simulation/stimulation equipment. Also conduct trade studies to validate the choice of drive electronics.

PHASE III: Transition the high-scene projector drive electronics technology to a production capable item. Expand the applicability of the drive electronics to other sensor test programs, as well as to commercial applications.

COMMERCIAL POTENTIAL: Commercial applications include associated information systems and communications areas requiring high data throughput driver electronics.

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KEYWORDS: Infrared Projection; Stimulation; Emitters; Missile Detection and Warning; Real-Time Data; Signal Analysis; Test and Evaluation

N99-188 TITLE: Novel Signal Processing Algorithms to Exploit and Classify Active Sonobuoy Returns

TECHNOLOGY AREAS: Sensors

OBJECTIVE: Use unique non-conventional signal processing concepts to enhance performance of future airborne Active ASW systems operating in high clutter environments.

DESCRIPTION: New ways are sought to separate "signals of interest" from "clutter". This may include making environmental measurements, developing techniques that involve the signal structure and /or clutter characteristics, or other information to make the classification. These techniques could be applied to the buoys in or proposed for the fleet's use. Our primary interest is Air Deployable Sensors. We are also looking for techniques that could aid, but not necessarily replace, the current classification techniques.

PHASE I: Define unique and innovative active signal processing concepts and classification algorithms that will exploit the signal structure and signal returns in an active (coherent and incoherent) airborne mission. The concepts must demonstrate significant if not total elimination of clutter and false alarms while enhancing the capability to detect the true signal. The concept must be low cost, simple and transportable for ease of implementation into existing and future active processing systems. The Phase I effort will identify the algorithms to be exploited, the system architecture, the techniques employed and signal exploitation. A working demonstration of the algorithm will be required.

PHASE II: Develop a redefined and fully working prototype of the algorithms and techniques defined and demonstrated under the Phase I. The prototype system will demonstrate the value added and performance attributes using real data furnished by the Government.

PHASE III: Implementation of the processing concepts and techniques in fleet ASW platform avionics (P-3, S-3, SH-60).

COMMERCIAL POTENTIAL: The system concepts and signal processing techniques developed under this task can be applied to commercial oceanography topography, bottom sediment characterization, environmental analysis and commercial sonar systems. These techniques could also be beneficial for commercial security and surveillance systems.

KEYWORDS: Anti-Submarine Warfare; Active Signal Processing; Novel Classification Algorithm Techniques

N99-189 TITLE: Small GPS Controlled Reception Pattern Antenna for Aircraft

TECHNOLOGY AREAS: Electronics, Electronic Warefare, Sensors, Modeling

OBJECTIVE: Develop and demonstrate a small controlled reception pattern antenna (CRPA) for naval aircraft applications that provides cost-effective anti-jam capabilities.

DESCRIPTION: The U.S. Navy and Marine Corps employ GPS navigation and targeting subsystems in a major fraction of current airborne weapon systems. Dependence on GPS continues to increase, making reliable and accurate GPS operation a critical requirement for successful mission accomplishment by current and future weapon systems. Battle situations are expected to present harsh environments for GPS operation, with high levels of radio frequency (RF) interference from spoofers, jammers, and other electronic warfare equipment, resulting in degraded GPS accuracy or complete loss of GPS operation. Spatial nulling by CRPA systems is very effective at countering these RF threats, and is the only reliable method for overcoming some types of threats. Conventional CRPA systems are large and expensive, and include antennas which are large, non-conformal, have high radar cross-sections (RCS), and otherwise unsuitable for current and future airborne platforms. Therefore, a need exists for a new GPS antenna system. The system should provide anti-jam capability against expected threats at an affordable price. It should be small enough for conformal installation aboard small airborne vehicles. Key technical challenges for this new antenna system include a) radiation pattern control with a small aperture area, b) electrically small broadband antenna elements, c) small and efficient nulling electronics and algorithm, and d) RCS control.

PHASE I: Trough a study of electrically small arrays for aperture size versus pattern agility versus implementation approach, design a preliminary system architecture, array configuration, and radiating element design(s). Generate measured and/or computational data of key system elements.

PHASE II: Design, fabricate, and demonstrate a proof-of-concept antenna system, including radiating elements, radome, and nulling electronics.

PHASE III: Transition this antenna technology for airborne integration, operation evaluation, and production, provided sponsorship is secured from F-18, JSF, F-14, EA-6, P-3, V-22 or other aircraft programs

COMMERCIAL POTENTIAL: This program is focused on providing the military with protection against intentional threats. Commercial users are faced with unintentional RF interference from television and radio broadcasts, PCS systems, Satcom systems, and other communication systems. Commercial GPS users also suffer performance degradation due to GPS signal multi path. The proposed new antenna will solve both of these civilian problems.

KEYWORDS: Antenna; GPS; Controlled Reception Pattern Antenna; Anti-Jam; Airborne

N99-190 TITLE: Expendable Broadband Projectors for Undersea Warfare

TECHNOLOGY AREAS: Sensors

OBJECTIVE: Develop innovative hardware for producing a broadband acoustic projector that will enable anti-submarine warfare (ASW) and mine warfare (MIW) sonar systems to adapt to harsh shallow water environments.

DESCRIPTION: Active sonar systems are very much affected by the environment within which they operate. This is particularly true in shallow water, where boundary interactions tend to defocus and lessen the strength of the source and echoes. Additionally, local bathymetric features along the path of the signals can obscure the signal or cause false returns, emulating real targets. Furthermore, surface, bottom, and volume reverberations add to the background noise level and reduce signal-to-noise level dramatically. Sonar systems that have the ability to change their operating parameters to adapt to the environmental characteristics will give better performance than less capable fixed parameter systems. These parameters include source level, beam pattern, frequency and waveform shape. A design concept should be developed based on innovative projector implementations, resulting in a transducer with high power, wide band frequency coverage and complex signal waveform capability. The overall objective is to develop an innovative transducer that is adaptable over a number of parameters, has high reliability, and is low in cost. Various transducer designs should be evaluated using appropriate mathematical models. A single design will be selected for in-depth evaluation.

PHASE I: Develop a detailed design for an innovative acoustic projector, including assembly drawings, modeling of predicted performance, and cost estimates. Analyze the performance based on simulated data such as that produced by state-of-the-art models.

PHASE II: Build a prototype acoustic projector of the design developed in Phase I, demonstrate its performance compared with the model predictions. Based on the results of testing, incorporate appropriate modifications to the performance models to better predict performance. Modify the transducer design if needed to improve performance.

PHASE III: Identify potential candidate Navy systems to transition the projector developed under Phase I and II. Build an improved prototype acoustic projector aimed at a specific Navy tactical application, showing advantages in cost or performance over the existing technology used or being considered for that application. Conduct sea tests and transition technology to an ongoing Navy acquisition program.

COMMERCIAL POTENTIAL: The technology developed should have applicability to a variety of commercial needs. Commercial potential is dependent on specific problems addressed but include off-shore petroleum and mineral exploration; ocean bottom mapping; underwater obstacle avoidance; underwater inspection services including environmental assessment; non-destructive evaluation of structures, and medical imaging technology; and enhanced underwater acoustic communications, for example among divers.

KEYWORDS: Active Sonar; Transduction; Sensor; Expendables

N99-191 TITLE: <u>Compact Mid-Infrared Laser for IRCM</u>

TECHNOLOGY AREAS: Electronic Warfare

OBJECTIVE: Develop a low-cost, small, lightweight mid-IR laser as a source for directed IR countermeasures (DIRCM) on board tactical aircraft.

DESCRIPTION: The most advanced threat to tactical aircraft is the IR missile threat. These IR missiles have accounted for more than 80% of all of the aircraft combat losses. The advanced IR threat may only be countered in the end game with a limited number of expendable IR decoys. Off-board countermeasures require multiple IR decoys deployed in the proper combinations, for a specific threat, at precisely the correct time. Improvements to existing threats and emerging advanced threats may render existing countermeasure techniques ineffective. An airborne DIRCM solution is needed to augment existing IR expendable decoys. The Navy seeks innovative advanced technology developments in the generation and propagation of directed laser energy. Tactical aircraft DIRCM systems require a compact, high-power laser source in the mid-IR band. Current IRCM lasers are costly and exceed weight, space and power constraints of Navy tactical aircraft. Promising laser technologies that may provide a low-cost, compact solution for tactical aircraft DIRCM systems will be assessed for feasibility, prototyped, integrated into an existing system and demonstrated for suitability. The selected laser technology must efficiently generate sufficient power to effectively jam IR missile seekers at distances large enough to prevent damage to the aircraft.

PHASE I: Research appropriate technologies; conduct atmospheric propagation analyses to define optimum lasing wavelengths; establish innovative concepts/approaches; perform tradeoff analyses; and define hardware, software, safety, and integration requirements. Prepare validation test plan and document results.

PHASE II: Prototype a DIRCM laser transmitter and perform the requisite analyses to integrate it with an existing CM system. The integrated laser will be tested in the laboratory and ground tested (long-range) to demonstrate acceptable performance. Deliverables will include the prototype laser, system interface control document (ICD), test plan, test report and a technical report documenting the performance parameters of the delivered laser.

PHASE III: Upon successful completion of the Phase II effort, the DIRCM system will transition to PMA-272 for use in defensive systems being developed for tactical fixed- and rotary-wing aircraft.

COMMERCIAL POTENTIAL: The successful mid-IR countermeasure solution can be commercialized for a multiple use to provide a laser that could be used by OSHA, EPA, and the Coast Guard in monitoring effluents from waste treatment plants, power plants, and ships. The FAA has and is still performing studies to assess installations of IRCM on commercial aircraft flying into certain areas of the world. These systems may be adapted to commercial aircraft to counter the growing terrorist threat to commercial aviation. It is not likely to equip a commercial aircraft with flare decoys. A compact laser provides for flexibility as it applies to available space, weight, and power.

KEYWORDS: Infrared; Infrared Countermeasures; Laser; Integration; Tactical Aircraft; Jammer; Directed IR Countermeasures

N99-192 TITLE: EO/IR Sensor Applications on Supersonic Vehicles

TECHNOLOGY AREAS: Materials, Sensors

OBJECTIVE: Develop techniques, which permit EO/IR sensors to operate in the high temperature environment of supersonic weapons and aircraft.

DESCRIPTION: Time-on-target requirements for land-attack weapons and aircraft have established the need for faster en-route and terminal velocities, often supersonic. EO/IR sensors, which perform target acquisition and track functions for the vehicles, are required to operate in very high temperature environments. The sensor dome or window, which isolates the sensor's internal optical system from the outside environment, must withstand the high temperatures while, at the same time, transmitting the optical radiation required by the sensor to perform acquisition and track. The purpose of this SBIR is to examine techniques, which might permit EO/IR sensors to effectively operate in high temperature environments of supersonic flight. Possible approaches include conductive or convective heat sinking, heat absorption by bi-state materials, coolant air on the window, closed or open cycle cooling, heat shields, etc. Geometrically position the sensor to a lower temperature location on the flight vehicle is permitted as long as it retains a field of view in the forward direction. In order to bound the technological requirements, respondees may consider supersonic flight up to Mach 4 at altitudes up to 60,000 feet. Sensor operating time at lower altitudes can be limited to two minutes at Mach 2 following a six-minute flight at Mach 4 at 60,000 feet. Cost will be an important consideration in any proposed solution. Currently available EO/IR sensors are limited in their application to supersonic flight conditions due to unacceptable deterioration of sensitivity or resolution or both. Infrared window and lens materials lose transmission capability or generate a high background flux, which greatly reduces system sensitivity. Respondees should not address the problem of EO/IR wavefront distortion due to the supersonic shock wave since that problem is being addressed elsewhere. Increased temperatures due to the shock waves, however, should be addressed. Proposed solutions should discuss the selection of window and lens materials, electronic components, gimbals, and detector arrays. Proposed sensors may operate in the visible or infrared regions and may include active or passive sensors.

PHASE I: Investigate various approaches that will allow EO/IR sensors to effectively operate in high temperature environments of supersonic flight. Demonstrate, through modeling analysis, the most promising approaches. The results of the Phase I effort should clearly demonstrate not only the feasibility, but establish a defined approach for a phase II effort.

PHASE II: Develop, test, and demonstrate under realistic conditions the most promising sensor approaches. Tests will demonstrate the capability of critical items such as windows and lenses to operate effectively in the high temperature environments. During Phase II, commercial and military sponsors for Phase III will be sought.

PHASE III: Build prototype sensors using the techniques and components demonstrated in Phase II. Apply to military and commercial sensors used in supersonic flight.

COMMERCIAL POTENTIAL: The technology developed in the SBIR will have a wide variety of commercial applications. Examples are supersonic aircraft which will employ passive or ladar sensors to perform safety area searches; re-entry vehicles which will use infrared or visible sensors for navigation or guidance after entering the earth's atmosphere; space vehicles which operate in planetary atmospheres such as Venus or Jupiter. Cooling techniques such as heat sinks have multiple private sector applications.

REFERENCES: References will be provided to DTIC for distribution to requesting bidders.

KEYWORDS: Sensors, Supersonic, High Temperature, Bi-State, Infrared Materials

N99-193 TITLE: GPS Ground Plane Nulling Antenna

TECHNOLOGY AREAS: Electronics, Electronic Warefare, Sensors

OBJECTIVE: Develop a low-cost GPS antenna that is effective against ground-based jammers.

DESCRIPTION: The development of the GPS navigation system has generated a myriad of users including weapons, aircraft, and ships. The effectiveness of this navigation system has prompted adversaries to exploit the vulnerabilities of the GPS navigation system by the use of ground and airborne GPS jammers. Tactical weapons are expected to be subjected to low power and moderate power jammers that are located on the ground. This SBIR will address how to counter ground-based jammers without resorting to the cost, weight, or power penalties typically associated with Controlled Reception Pattern Antennas (CRPA). The low-cost antenna is expected to provide nulling of GPS jammers on the ground and reception of GPS satellite signals.

PHASE I: Define innovative antenna design concept(s) that provide a minimum of 20 dB attenuation of signals (objective 30 dB) that are less than 5 degrees above the antenna horizon. The antenna should also provide a 0 dB or greater gain more than 20 degrees above the antenna horizon. The antenna should have a design to cost goal less than $1,000, require no electronic processing or electrical power, possess stealth characteristics, and have a twenty-year shelf life. The antenna is mounted on the top of the weapon conformal to a flat surface. The new antenna design will replace an existing antenna with a three-inch aperture. More specific form factor requirements will be provided by the Government during this phase. Phase I should demonstrate the feasibility of the design through analysis or breadboard hardware. Initiate the design of a prototype antenna that can be fabricated and tested during phase II.

PHASE II: Finalize the design, fabricate, and test the selected antenna concept evolving from the phase I program. The testing should include both RF gain pattern characterization and survivability characterization. Initiate producibility studies of the design along with production planning and design to cost analysis. Fixtures to support the testing may be provided by the Government.

PHASE III: Build 10 ship sets that will be used by the government for flight test, environmental qualification, and reliability development/growth testing. Provide engineering support via corrective action redesign resulting from the above testing.

COMMERCIAL POTENTIAL: This antenna concept is applicable for any commercial application of GPS which is subjected to electromagnetic interference such as business aircraft or helicopters flying in and out of populated areas. It would be particularly useful for commercial aircraft, which might be subjected to potential terrorist threats employing low power GPS jammers around airports. The commercial market could drive the cost of the antenna below the desired $1,000 cost objective.

KEYWORDS: GPS; Antenna; Countermeasures; Weapon; Precision Attack

N99-194 TITLE: Low Cost GPS Oscillator

TECHNOLOGY AREAS: Electronics, Electronic Warfare, Sensors

OBJECTIVE: Develop a low-cost GPS oscillator that meets military GPS accuracy requirements.

DESCRIPTION: The development of the GPS navigation system has generated a myriad of users including weapons, aircraft, and ships. The GPS receivers, referred to as the user equipment, use a high quality crystal oscillator to receive and properly interpret the GPS signals from the GPS satellites. This SBIR will address the development of a temperature compensated or other low power oscillator that provides the same quality performance as today's oven controlled crystal oscillators without the size, weight, power, and cost penalties of the oven controlled oscillator.

PHASE I: Develop a crystal oscillator design concept and perform analyses to verify that the design will meet the following characteristics. The oscillator will cost less than $200 (goal less than $100), use less than two watts of power, support fast response over the standard military temperature range (rated stability within 30 seconds - goal of 3 seconds), and provide good long term stability (1 ppm over 20 yrs) and good short term stability (< 5 x 10 e -10 rt Allan variance, t = 0.1 sec - goal of < 3 x 10E-11 rt Allan variance, t = 1.0 sec). Initiate the design of an engineering prototype oscillator than can be fabricated and tested during Phase II.

PHASE II: Finalize the design. Fabricate, and test the selected crystal oscillator concept evolving from the Phase I program. The testing of the engineering prototype should include testing over the entire environment range. Initiate producibility studies of the design along with production planning and design-to-cost analysis. Provide three test articles to the Government for early engineering assessment.

PHASE III: Build 10 production representative units that will be used by the Government for flight test, environmental qualification, and reliability development/growth testing. Provide engineering support via corrective action redesign resulting from the above testing.

COMMERCIAL POTENTIAL: This oscillator design is applicable for any commercial application of GPS which desires low power utilization combined with rapid response. This oscillator would improve GPS performance where the receiver is subjected to electromagnetic interference such as business aircraft or helicopters flying in and out of populated areas.

KEYWORDS: GPS; GPS Receiver; Crystal Oscillator

N99-195 TITLE: Real-Time Pattern Recognition Algorithms for High Density Commercial and Military Applications

TECHNOLOGY AREAS: Computing, Sensors

OBJECTIVE: Develop algorithms which can perform real time pattern recognition for applications involving real-time inspection of hundreds of images or other digitized files with minimum expenditure of processor memory and throughput.

DESCRIPTION: Increasing numbers of military and commercial systems are faced with the task of automatically performing pattern recognition examinations of a large number of very large digital files. The digitized data can contain fingerprint records, digitized photographs, DNA records, eye prints or any number of other records which must be examined in order to find a match to a reference file. An example is a face recognition system located in an airport or other busy location. The system would have to compare real time video imagery with stored photographs in order to recognize a person (s) being sought. Another example is that of finding a commercial or military object of interest, such as a potential military target, immersed in a cluttered background. Current autonomous recognition capabilities are limited by the immense memory and processing throughput requirements associated with real time correlations of large files of digitized data. Several techniques have evolved to lessen the memory and throughput limitations. They include data compression; use of mathematical techniques such as Fourier transforms in order to process in complex space; Hough transforms for edge correlations; use of templates such as edge templates, corner templates, or other geometric templates; polarization techniques; and fuzzy algorithms such as neural networks. The purpose of this SBIR is to identify those innovative algorithms which show most promise of being able to perform pattern matching of hundreds of digitized records in real time.

PHASE I: Identify and analyze algorithms that show the most promise of being able to perform pattern matching of hundreds of digitized records in real time. Select the most promising algorithms.

PHASE II: Develop, test, and demonstrate under realistic conditions the most promising real time autonomous pattern recognition algorithms. Where it can be done economically, with non-SBIR funding, comparisons of the SBIR-tested algorithms with other available pattern recognition algorithms will be performed. During Phase II, commercial and military sponsors for Phase III will be sought. Commercial and Governmental agencies which are potential users of the algorithms include: law enforcement agencies, health agencies, and environmental protection agencies.

PHASE III: Build prototype real-time autonomous pattern recognition systems using the techniques demonstrated in Phase II. Apply to military seeker and FLIR systems as well as to commercial imaging and pattern recognition systems. Examples of military systems which may employ the algorithms are Stand-off Land Attack Missile with Expanded Response (SLAM-ER) and the Joint Service Stand-off Weapon (JSOW).

COMMERCIAL POTENTIAL: Increasing numbers of commercial systems are faced with the task of performing pattern recognition examinations. The new algorithms will have a wide variety of possible applications such as identifying individuals at airport security checks, DNA pattern correlations, finger and eye pattern correlations, and airborne searches of cluttered ground scenes for items of interest. Currently available Autonomous Object Recognition (AOR) algorithms are computationally intensive. It is expected that the algorithms which are identified and tested as part of this SBIR will be more efficient and not require special equipment such as specialized correlators. The resulting AOR algorithms will have the potential to provide expanded capabilities to law enforcement and health research agencies as well as to military systems. If the SBIR is successful, video imagery and/or computer files will be examined much more quickly, either in real time or during playback, in the search for a particular object of interest. In addition to the business-oriented applications, home-oriented security applications are possible as, for example, the identification of visitors or intruders.

N99-196 TITLE: Geometric Patterning of Radar Absorptive and Reflective Materials (RARM) and Selective Combining of RARM materials to Achieve Improved Electromagnetic Interference (EMI) Protection and Significantly Reduced Radar Cross Sections (RCS)

TECHNOLOGY AREAS: Materials

OBJECTIVE: Investigate various shapes and patterns of RARM materials to ascertain which geometric patterns result in improved EMI protection and reduced RCS. Investigate which combinations of RARM coatings give improved EMI protection and reduced RCS. The end result of this demonstration will be an EMI-reduction/radar cross section technology that provides equal or better protection to military and commercial aircraft, land craft, and sea craft.

DESCRIPTION: Commercial and military vehicles are faced with the need to operate properly in high EMI fields. They are also often at risk if their RCS permits easy detection by opposing radar systems. Military systems include missiles, aircraft, ships, and ground vehicles. Commercial vehicles include coastal security craft, space vehicles, and aircraft that operate near high-power radar. Current RARM coatings are costly and heavy. They often do not give significant protection over large angles and are limited in frequency range. Their performance is often limited by the shape and size of the vehicle that they cover. It has been shown that properly shaped RARM coatings can provide more protection than uniform coatings. Shaped coatings can reduce the EMI/RCS in areas where it is the hardest to achieve results such as broad side. Shaping the RARM can provide equal or better protection while using significantly less material. The result is less cost and weight. The use of properly applied RARM results in larger production buys and increased vehicle mileage due to reduced weight and volume. Current investigations of EMI/RARM materials are concentrated in the area of investigating the materials themselves. Few demonstrations of the improvements achievable from geometric shaping have been conducted. Fewer still are documented. Although much progress has been reported in the development of materials, little progress has been reported in the area of combining those materials to provide protection to various areas of the base vehicle.

PHASE I: Identify the most promising methods of geometric patterning and RARM materials to improve EMI protection and reduce RCS.

PHASE II: Develop, test, and demonstrate under realistic conditions, the most promising shapes and combinations of RARM to provide additional protection over current methods of applying RARM.

PHASE III: Build and test prototype RARM-protected bodies using the techniques demonstrated in Phase II. Apply to military systems as well as to the most promising commercial systems.

COMMERCIAL POTENTIAL: The new algorithms will have a wide variety of commercial applications. Many commercial systems have to operate in the vicinity of high-power radar. EMI protection will be provided by the technologies developed under this SBIR. Some commercial vehicles seek lowered RCS for security reasons. The technology provided in this SBIR will help provide the required protection at a lower cost and weight.

KEYWORDS: Radar; Radar Cross Section; Electromagnetic Interference; Radar Absorbing Materials

N99-197 TITLE: Handheld Remote Fuel Quality Sensor

TECHNOLOGY AREAS: Sensors

OBJECTIVE: This topic seeks to develop an advanced portable fuel quality monitor capable of wireless transmission of data using the latest TCP/IP protocol. The resulting hardware will enable real-time, on-site determination of fuel type and quality, when "clear and bright" isn't enough. DESCRIPTION: The military needs to the capability to assess the quality of host nation or captured fuel supplies in near real time. Additionally, they need the capability to retest and certify stored or cached fuel across a distributed battlefield. A number of vehicle maintenance problems can be attributed to poor quality or contaminated fuel. These maintenance problems impact life cycle cost and readiness.

Generally, fuel is tested on receipt from the refinery, or when vehicles are diagnosed with fuel-related problems. Fuel testing is a time consuming procedure of collecting samples, sending them to a laboratory (rear area), and waiting for results. The time lag is double edged; corrective action can't be initiated until results are returned, and the stock of "suspect" fuel can't be distributed until it is certified "clean" thereby creating an additional burden on the logistics supply line to provide certified fuel until the stock on hand is deemed acceptable.

The United States Marine Corps (USMC), in conjunction with the US Army, is seeking development of the capability to determine fuel type and quality on site, in real-time. The basic concept is to determine fuel type and quality wherever fuel is stored, transferred, or dispensed. As a concept of operation, this can include assessing captured fuel supplies, caches of pre-positioned packaged fuel, or in-line fuel. The concept of operations dictates that the test unit be man-portable, and preferably hand-held. This topic seeks approaches utilizing sensor technologies that may involve, but are not limited to, near-infrared/infrared spectrometers integrated with wireless transmission of data using TCP/IP. The prototype system may be designed to function solely with all diesel fuels, but further development should yield equipment suitable for use with Kerosene based fuels, and various grades of gasoline as well. Fuel quality shall be determined in view of several properties, which may include moisture, density, viscosity, total aromatics, cetane index (diesel), octane rating (gasoline) cloud point, and net heat of combustion. Calibration models for over 30 fuel properties currently exist in industry and provide varying degrees of accuracy. The properties or approach selected for the determination of fuel quality shall be chosen on the bases of providing the most accurate estimates concerning the quality of the fuel.

PHASE I: Determine, define and establish acceptable fuel quality parameters for Marine Corps and Army vehicles providing information in a prioritized format. Define the high priority fuel quality parameters on a vehicle by vehicle or engine type (piston, turbine) basis, and relate this to the maturity or feasibility of sensor technologies to measure those parameters. Present findings in such as manor as to facilitate down-selection and project focus. Develop designs and demonstrate the technologies to determine and assess the previously prioritized priorities fuel quality parameters using sub-component sensors. The sub-component sensors shall be used to rapidly assess fuel parameters by direct contact with fuel through vents, caps, valves, or other orifices.

PHASE II: Develop and integrate those sensing components into a single hand held fuel quality monitor. Integrate data outputs from the sub components into a usable TCP/IP format suitable for wireless transmission. Demonstrate the hand held fuel sensor in view of phase I definitions of acceptable fuel qualities.

PHASE III: Develop a "smart" fuel quality data base which will provide information integrating the fuel sensor real-time data with "smart" decisions to provide remedial action necessary to bring the unacceptable fuel quality to acceptable levels or suggest alternate uses for the product.

COMMERCIAL POTENTIAL: The development of a compact, handheld, remote fuel quality sensor has broad application in the trucking, mining, timber and agricultural industry where large quantities of fuel are stored and used in remote locations. The fuel is generally transferred directly from temporary storage to the fuel tanks of the end user equipment where single deterrent to engine and environmental problems arising from contaminated fuel is the fuel filter. Department of Transportation enforcement officers could use the device to verify that appropriate highway taxes have been paid on fuel used for highway transport of commercial goods.

REFERENCES: Remote near-Infrared Fuel Monitoring System, Dec 97 by Southwest Research Institute; available through DTIC-OCC, 8725 John J. Kingman Rd, Suite 0944, Fort Belvoir, VA 22060-6218

KEYWORDS: Fuel; Quality; Sensing; Logistics

N99-198 TITLE: Ray-tracing Tool for directly interrogating Pro-Engineer Geometry

TECHNOLOGY AREAS: Modeling

OBJECTIVE: Develop a standalone UNIX based program that can directly interrogate a Pro-Engineer geometry and produce Line-of-Sight (LOS) raytrace information to support vulnerability, lethality, and signature analyses.

DESCRIPTION: Current state-of-the-art survivability assessments use a Computer Aided Design (CAD) generated 3D target description to model threat penetration and damage. A shotlining or raytracing program is used to simulate the target/threat interaction by taking a ray and passing it through a target to produce LOS information. The AAAV Program currently has requirements to assess the vulnerability of their vehicle using the Modular Unix-Based Vulnerability Estimating Suite (MUVES) suite of assessment models. The AAAV was designed using Pro-Engineer. Because the MUVES model can only be used to generate LOS information for Ballistic Research Laboratory Computer Aided Design (BRLCAD) geometry's, the AAAV Pro-Engineer CAD geometry must be converted to BRLCAD format. The conversion of the geometry from a Pro-Engineer format into a BRLCAD format is an extensive effort and sometimes produces component representations that are not optimal for the subsequent vulnerability assessment. A raytracing tool is needed that uses an open and standard interface to directly interrogate the Pro-Engineer geometry. This would eliminate the need to perform geometry conversions to the BRLCAD format and would directly support not only the AAAV's vulnerability assessment needs but could support signature and reparability assessments as well. This tool would be designed as a standalone raytracing capability to respond to survivability programs such as the Advanced Joint Effectiveness Model (AJEM), MUVES, Stochastic Analysis of Fragmentation Effects (SAFE), Computation Of Vulnerable Area and Repair Time (COVART) model, etc. The capability to directly interrogate Pro-Engineering geometry's will ultimately produce significant savings in the time and effort required to perform survivability assessments (including signature, vulnerability and reparability analyses) for systems designed using Pro-Engineer.

PHASE I: A standalone prototype Pro-Engineer geometry raytracing tool will be developed and demonstrated. The prototype should demonstrate that simple component level geometry's (i.e.; cylinders, boxes, etc.) can be accurately raytraced and that accurate evaluation of components and materials (i.e.; material encountered, material thickness, incident angles correctly identified, etc.) along the shotline is accomplished.

PHASE II: The raytracing tool will be expanded to address all Pro-Engineer geometry combinations (i.e.; complex geometry combinations). A fully functional Pro-Engineer raytracing tool that accurately identifies materials, material thickness and incident angles for every item intercepted along the shotline will be delivered. The raytracer will produce accurate data for any impact point on the target and all possible impact and yaw angles for each impact point. The raytracing tool will be optimized for speed and will be integrated into a Sponsor-selected analysis code.

PHASE III: Market the tool to other vehicle, aircraft and systems designers (including military and commercial radar, infrared and thermal imager designers) who are currently using Pro-Engineer to design vehicles/systems that require vulnerability analysis. Modify the tool as necessary to meet aircraft, ship or other system unique requirements or to address designs accomplished using other CAD programs.

COMMERCIAL POTENTIAL: This tool will aid aircraft, surface ship, submarine, combat vehicle, space vehicle, and armored car/limousine designers who are currently using Pro-E in evaluating the survivability of their designs. This tool has immediate applicability to the Army's Crusader, M1A2 Tank 2000, HIMARS, Grizzley and Kiowa Warrior programs. Additionally this product can support survivability assessment of Pro-E designed facilities that may be subjected to terrorist attack (i.e.; nuclear power facilities, embassies, Government buildings, key factories, etc.). This tool has applicability to both signature and vulnerability assessments. Both military and commercial radar, infrared and thermal imaging system designers routinely analyze the effectiveness of their designs using raytracing tools such as the one proposed in this SBIR. Providing them the ability to directly interrogate systems they are interested in has the potential to significantly reduce costs shorten the assessment process.

REFERENCES: The following references provide a description and source documentation for MUVES and BRLCAD applications used in assessing vulnerability, system signature and repairabilty. The references describe model architecture, raytracing requirements, model input requirements and formats (including BRLCAD). Additionally they describe special requirements and usage of MUVES modules such as SAFE, SPRAE and COMPART.

1. Hanes, P.J., et.al., "Modular UNIX-based Vulnerability Estimation Suite (MUVES) Analysts Guide", US Army Ballistic Research Laboratory Memorandum Report No. 3954, December 1991.
2. Murray, K.R., et.al., "Modular UNIX-based Vulnerability Estimation Suite (MUVES) Analysts Guide, Release 2.0 - Draft", US Army Research Laboratory, Aberdeen Proving Ground, Maryland, May 1994.
3. Bain Jr, L.W.., et.al., The Gift User Code Manual; Volume 1, Input Requirements", US Army Ballistic Research Laboratory Report No. 1802, July 1975.

KEYWORDS: Vulnerability assessments, BRLCAD, Pro-E, raytracing, MUVES

N99-199 TITLE: Real Time Motion Capture for Virtual Reality

TECHNOLOGY AREAS: Human Systems, Manpower, Modeling

OBJECTIVE: Provide a high fidelity depiction of humans immersed in a shared virtual environment by capturing the persons full body movements, facial expressions, and eye gaze direction to allow realistic verbal and non-verbal communications between two or more immersed individuals.

DESCRIPTION: Depicting humans in a shared virtual environment realistically enough to allow recognition of particular individuals from body postures and motions and to allow non verbal communications requires accurate capturing of the individuals body parts and motions. The Marine Corps Small Unit Tactical Trainer (SUTT) advanced technology demonstration and the Army Dismounted Warrior Network (DWN) experiments have shown that simple animated humans are not adequate for realistic interactions in a shared virtual environment. Current tracking systems are not capable of tracking an entire human fast enough and/or accurately enough in harsh environments such as on board ship. Current magnetic and acoustic tracking systems are inadequate even in ideal laboratory conditions and are not capable of operating in a deployed ship setting. Inertial systems have drift and accuracy problems that require augmentation with other trackers to even work at all. This leaves an optical tracker as the only potential solution. Current optical trackers based on cameras and image processing are not accurate enough or cost effective. The tracking system must have much better than one millimeter accuracy to track a weapon well enough to perform realistic marksmanship and the target price for a complete real time motion tracking system which meets all the Phase II requirements should cost less than $25K. Current optical tracking systems cost ten times that amount and don't perform adequately. Software must be provided which takes the raw tracker data and processes it in order to distribute the necessary information required by the distributed system's renderer. The human should be untethered by the tracking system. The system should calibrate quickly and easily and require minimal setup or preparation time for each individual. The system should allow the human to operate within a 10 foot square room with an 8 foot ceiling and provide reliable data for the human and weapon anywhere within that room at all times.

PHASE I: Develop a non-tethered prototype tracking system that can track an entire human body and a weapon to better than one millimeter accuracy. This should be accomplished within a 10 foot square room with an 8 foot ceiling and provide the necessary information to visually render the human in a distributed shared virtual environment.

PHASE II: Extend the system to track individual fingers, mouth and lips for talking, facial expressions and eye position for realistic face to face verbal and non verbal communications. Add the ability to depict walking, running, crawling, dying, etc. in the virtual world without actually performing those tasks in the real world. Demonstrate the system in an actual HLA dismounted infantry distributed simulation.

PHASE III: Apply technology to enhance Indoor Simulated Marksmanship Trainer.

COMMERCIAL POTENTIAL: This system is applicable to any virtual reality application (training, games, etc.) where high fidelity humans are required. This system is also applicable to the entertainment industry for motion pictures, cartoons, etc.

REFERENCES: Dismounted Warrior Network, Front End Analysis Experiments Final Report, Do#0020, Sept 15, 1997 ADST-II-CDRL-DWN-9700392, CDRL AB06

KEYWORDS: optical tracker; animated humans; virtual environment; verbal and non-verbal; SUTT; and marksmanship

N99-200 TITLE: Non-Lethal Clearing Facilities of Personnel

TECHNOLOGY AREAS: Battlespace

OBJECTIVE: Enable operator to clear all personnel from a facility without having to enter the building and conduct traditional room to room inspection and clearing operations.

DESCRIPTION: The ability to non-lethally clear facilities of all personnel is desired for conducting military operations in urban terrain (MOUT) and other areas where inhabited facilities are within the battlespace. Such settings are challenging from a military perspective since there are many places where combatants can hide and set up ambushes. This ability is also useful for removing noncombatants from a military target such as a weapons manufacturing facility prior to a lethal strike. The proposed technology solutions should be effective, non-lethal to personnel, and produce little to no structural damage to the facility. The proposed technology solution should also not be easily countered. Delivery of the proposed solution must be possible from at least 50 meters from the facility with ranges beyond small arms range (>500m) being preferred. Traditional methods such as tear gas and pepper spray are effective for small one-room structures, but the effectiveness diminishes with larger facilities and multiple rooms. The proposed solution needs to be effective for large, multi-room structures. It also needs to be easy to transport and easy to deliver/deploy.

PHASE I: Determine candidate technology solution(s) and conduct initial testing to demonstrate potential for technology to non-lethally clear facilities of all personnel. Health effects must be addressed at this phase to show that the technology solution(s) is non-lethal to personnel.

PHASE II: Demonstrate technology solution(s) for a two or more story structure with multiple rooms and at least 5000 square feet of total space. This demonstration should involve human test subjects, and as such the correct protocols need to be approved. Develop conceptual delivery mechanism capable of delivering the technology solution(s) from at least 50 meters from the facility.

PHASE III: Build prototype delivery system for technology solution(s) and demonstrate effectiveness of complete system against large (15,000 square feet) multi-story, multi room facility from a range of at least 50 meters with >500 meters preferred. This demonstration should involve human test subjects, and as such the correct protocols need to be approved.

COMMERCIAL POTENTIAL: This system could be used by law enforcement agencies for breaking barricades and for hostage rescue situations.

REFERENCES: Joint Non-Lethal Weapons Concept, Signed by LtGen M.R. Steele, Deputy Chief of Staff for Plans, Policy, and Operations, U.S. Marine Corps on 1/05/98, Available on World Wide Web at www.hqmc.usmc.mil/nlw/nlw.nsf

KEYWORDS: Clear Facilities; Non-Lethal; MOUT

N99-201 TITLE: Armored Vehicle Internal Noise Reduction System

TECHNOLOGY AREAS: Environmental, Human Systems, Surface

OBJECTIVE: Develop a system to reduce/cancel noise in the interior of an armored vehicle to a level that hearing protection is inherent to the vehicle and would not require the crew and/or other personnel inside the vehicle to wear hearing protection.

DESCRIPTION: The need is to provide an area active noise cancellation/reduction system that would monitor the noise levels and frequencies and remove/reduce them to level that would permit a conversation at normal/near normal voice levels. Current noise reduction means all require the personnel to wear either passive or active noise suppression devices to reduce the noise level in the vehicle. Noise levels in the Advanced Amphibious Assault Vehicle (AAAV) will exceed acceptable levels and will require some form of hearing protection. To effectively operate in a combat situation close coordination is necessary between individuals. When working in armored vehicle noise levels preclude virtually all voice communications and generate harmful levels of noise. An effective vehicle wide, noise cancellation/reduction system would permit effective voice communication to occur inside the vehicle. The system must be lightweight, low power and small enough so as to be easily installed into an armored vehicle without impacting on the personnel. Noise levels will need to be reduced from a nominal 120+ dba to 75dba. Noise is primarily from engine noise and track induced vibration.

PHASE I: The program is expected to result in the identification of potential technologies and the design of a prototype unit that would be produced in Phase II. The Phase I design would include a modeling effort to validate the design and its implementation/integration into to the AAAV. The Phase I effort is expected to incorporate a consideration of manufacturability, and reliability.

PHASE II: Build and test a prototype unit and perform lab testing in an environment similar to that of the AAAV to mature and validate the design.

PHASE III: Market the system for use in any human occupied area with excessive noise levels.

COMMERCIAL POTENTIAL: Both military and commercial systems would benefit from the availability of an area wide noise cancellation system. This technology would be useful in a wide range of applications in ground and aviation vehicles as well as commercial application where manufacturing systems and activities produce excessive noise levels.

REFERENCES:
1. Active Noise Control Systems: Algorithms and DSP Implementations, Sen M. Kuo,With Dennis R. Morgan / Hardcover / Date Published: January 1995
2. Active Noise Control: Fundamentals for Acoustic Design G. Rosenhouse / Hardcover / Date Published: March 1998
3. Active Control of Noise and Vibration C. H. HANSEN,SCOTT SNYDER / Hardcover / Date Published: November 1996

KEYWORDS: Noise cancelling, hearing protection

N99-202 TITLE: Remote Meteorological Sensor Package

TECHNOLOGY AREAS: Sensors

OBJECTIVE: This topic seeks to develop an advanced, low probability of detection, means to sense atmospheric conditions from a single location for radial distances of 1 to 184 Km and altitudes of 0 to 30 Km inclusive. Conditions of interest are wind speed, wind direction, air temperature, barometric pressure, air density, and humidity at multiple altitudes and distances. This capability would replace the current capability. The system must be transportable by a single HMMMV or a HMMWV and trailer combination is also acceptable.

DESCRIPTION: The Marine Corps needs the ability to collect information on atmospheric condition in any operational area. Today, the information is collected by sensor packages carried by hydrogen filled balloons. A radio accompanies the sensors to transmit data to a ground center for analysis and processing. Dispersion of the sensors is at the mercy of the winds at the time of release.

PHASE I: Analyze methods of sensing atmospheric conditions without using a balloon borne sensor and radio package. Perform a feasibility study of the alternatives, report the results of the study, and recommend two best value alternatives for providing the capability based on cost, schedule, and technical performance. The system must be a portable, self-contained unit that can be set up and operated by no more than two individuals in less than 15 minutes.

PHASE II: Build a prototype of the alternative from Phase I that is selected by the government. The prototype shall be made to best commercial practices. Develop a commercial marketing plan for the system.

PHASE III: Further develop the system for both commercial and military applications. The resultant shall be made commercially available by the close of Phase III.

COMMERCIAL POTENTIAL: Private and public organizations have a need to collect atmospheric information to report weather conditions and to produce weather forecasts. The system could be use to generate information for agricultural, aviation, news, and weather organizations.

REFERENCES:
(1) Mission Need Statement for the Meteorological Measuring System dated 1993
(2) Operational Requirements Document for Meteorological Mobile Facility dated 1996
(3) Operational Requirements Document for Meteorological Mobile Facility Replacement dated 05 May 1996.

KEYWORDS: Meteorology; Remote Sensors; Weather; and Winds Aloft

N99-203 TITLE: Fiber Optic Multi-pin Connector for Towed Arrays

TECHNOLOGY AREAS: Sensors

OBJECTIVE: Develop a low-loss, low-reflection, multi-pin, fiber optic connector capability for optical towed array sonar applications.

DESCRIPTION: The Navy is developing low cost passive optical acoustic sensor technology for use in future Navy towed arrays. To deploy these arrays from tactical platforms, multi-pin fiber optic connectors are required with the following capabilities/characteristics: a minimum capacity of 8 single mode optical fibers, an optical wavelength of 1530-1565 nm, 0.5 dB max optical loss per pin, transient peak power of +40 dBm, and a goal of less than - 60 dB optical back reflection per pin. The multi-pin connector inserts must be designed to operate within existing towed array connector shells. Drawings of the connector shell are available on request. The backside of the insert is exposed to ISOPAR L at pressure. The connection side of the insert is in air but materials should be compatible with ISOPAR L. The multi-pin fiber optic connector shall operate in a towed array environment with the following characteristics: 1200 psia operating pressure, 2500 psia survival pressure for 1 hour, -2oC to +40oC operating temperature, -28oC to +65oC storage temperature. The connector insert body dimensions may not exceed 0.625 inches diameter by 2.64 inches length. The connector's optical performance should not degrade more than 1.0 dB over 1000 mate-demate cycles, or more than 1.5 dB over the life of the connector. Capability of handling polarization-preserving fiber is a goal.

PHASE I: Develop a prototype multi-pin fiber optic connector which will meet the above performance and mechanical requirements. This multi-pin fiber optic connector may be a laboratory breadboard; however, the design must clearly be capable of meeting the dimensional and environmental requirements.

PHASE II: Develop and test a fully functional multi-pin fiber optic connector. Deliver several multi-pin fiber optic connectors to the Navy for preliminary testing.

PHASE III: Produce multi-pin fiber optic connectors for incorporation into military and civilian towed arrays.

COMMERCIAL POTENTIAL: These multi-pin fiber optic connectors could be applied in any environment that required passing multiple optical signals through a small bulkhead.

KEYWORDS: Fiber-optic, towed arrays, connectors, acoustic arrays, mateable, multi-pin

N99-204 TITLE: WATER BASED HYDRAULIC SYSTEM

TECHNOLOGY AREAS: Materials

OBJECTIVE: To develop an environmentally benign hydraulic fluid, such as a water based system, to eliminate releases from current petroleum based systems that have the potential to create an adverse impact to the environment.

DESCRIPTION: The Clean Water Act, Section 311, 40 CFR 110, various State water quality standards, and OPNAVINST 5090.1B prohibit the discharge of petroleum products in such quantities as may cause a film or sheen upon or discoloration of the surface of the water, or violate water quality standards. In addition, since the effects of acute toxicity associated with the additives used in hydraulic fluid is currently unknown, it would be prudent to identify/develop an environmentally benign substitute.

PHASE I: Determine the scientific, technical, and commercial merit and feasibility of developing a water based hydraulic system for use on Navy submarines. The contractor shall submit a report describing the proposed technology, how it will be developed and tested, operation, maintenance, efficiency, effectiveness, estimated cost, training requirements, and identification of other commercial benefits. The report shall contain all data generated during the investigation of the recommended technology.

PHASE II: Develop a prototype for testing. Prepare an implementation plan to demonstrate the technology on an operating submarine that will include installation, monitoring, and performance evaluation requirements. The contractor shall prepare a final report assessing the demonstrated technology.

PHASE III: A small business Phase III award is predicated upon a successful technology demonstration that will allow consideration for implementation into the fleet.

COMMERCIAL POTENTIAL: Although the Navy's submarine fleet will be the principal beneficiary of a successful demonstration, the potential exists for the technology to be implemented on Navy surface ships, other DoD weapon systems, non-military vessels, and at facility installations where the use of a water based hydraulic system is a viable alternative to petroleum based systems.

REFERENCES: Initiation Decision Report (IDR) on Water Hydraulics for Submarine External Hydraulic Systems. Dr. Mike Klinkhammer, Report No. CDNSWC-TR-63-98/32, Dec 98.

KEYWORDS: Submarine; hydraulic; water-based; petroleum; environmental; Clean Water Act

N99-205 TITLE: Search and Rescue (SAR) Using Active Light Detections and Ranging (lidar) Technology

TECHNOLOGY AREAS: Modeling

OBJECTIVE: Develop specific SAR algorithms to be used in the Navy's Magic Lantern Deployment Contingency (ML(DC)) and Advanced Technology Development project number 111 (ATD-111) lidar systems to supplement the Navy's SAR capabilities and decrease search time.

DESCRIPTION: Two active lidar systems currently being flown by the Navy are the ML(DC) and ATD-111 systems. The ML(DC) system was developed for the Mine-Countermeasures mission and is flown by personnel at Helicopter Squadron Light Airborne Multi-purpose Nine Four (HSL-94). The ATD-111 system was developed for the ASW mission and is flown by personnel at Naval Air Warfare Center Aircraft Division Patuxent River (NAWCAD PAX). Both systems have the capability for detecting small (man-sized) object on the surface of the water. Because the systems can search and process data much faster than an operator, the SAR mission could greatly be enhanced, especially at night, by use of these systems. However, the search algorithms for a survivor have not been developed. While there are only a few ML(DC) and ATD-111 systems, the Airborne Laser Mine Detection System (ALMDS) will be put into production within the next three years to replace the ML(DC) systems and be provided to the active duty Fleet. Reference (1) contains information regarding both ML(DC) and ATD-111 design and operation. Information regarding ALMDS that is available for public access is located at http://www.ncsc.navy.mil/CSS/Projects/ALMDS/almds.htm.

PHASE I: Determine the statistically best modes of operation to search for the following - 1) Single survivor no raft, 2)Single survivor w/raft, and 3)Four man raft. Also, analysis should be conducted on the effects of sea dye marker (e.g., increased contrast that would allow better detections). Suggested implementation, that is changes to the existing software code, should also be submitted.

PHASE II: Implement the suggested changes and perform in-field testing using the ML(DC) and ATD-111 systems on the SH-2G and SH-60B helicopters. Targets and ground truthing will be also need to be used to determine SAR capabilities. Development of lidar SAR search patterns and methods of increasing probabilities of detection will need to be accomplished. Modification of the existing ML(DC) ground station to include SAR briefing cards, areas cleared, and residual threat (i.e., chance that the survivor was missed) will need also need to be accomplished. A briefing and training course will need to be developed so that currency in performing the lidar SAR mission can be maintained. Lessons learned not only from training but also from the data collection will need to be compiled in preparation for final product delivery to the Fleet.

PHASE III: Develop a lidar SAR update package for the ALMDS (with Phase II software remaining in the ML(DC) and ATD-111 systems). This package should contain software code for the ALMDS sensor, code/algorithms for the ALMDS ground station that is expected to be MEDAL compliant, lessons learned, course of instruction, and pocket checklist/briefing cards.

COMMERCIAL POTENTIAL: The U.S. Coast Guard and analogous overseas organizations would be the primary customer but local law enforcement and civil air patrol could also benefit from use of this SAR development.

REFERENCES:
(1) (U) Coastal Systems Station Document, Test Report, Airborne Mine Countermeasures, Competitative Evaluation Field Test, March 1998 (C) *Title unclassified, document confidential.*
ALMDS information is currently procurement sensitive. Information approved for public release can be found on the Internet at the following address: http://www.ncsc.navy.mil/CSS/Projects/ALMDS/almds.htm

KEYWORDS: Lidar; SAR; search patterns; tactical decision aid; training; Airborne Laser Mine Detection System (ALMDS)

N99-206 TITLE: <u>Fault Diagnostics For Waterfront Construction</u>

TECHNOLOGY AREAS: Materials

OBJECTIVE: Develop cost competitive, long-lived fault diagnostic systems for Navy waterfront construction having a zero maintenance requirement for 75 years in a severe marine environment.

DESCRIPTION: The Navy is demonstrating the feasibility of constructing waterfront pier and wharf structures using high performance concrete and FRP composite materials to meet changes in ship characteristics, force realignments, and rapid buildup of infrastructure. The structural designs will maximize maintenance free service life while providing a competitive initial cost with conventional construction. The Navy has a need to develop fault diagnostic systems to monitor its high performance waterfront infrastructure. The system must provide an analog of load performance including lateral load response, vertical load response (static, creep), as well as perform as a structural health monitoring system. The instrumentation design must employ real time sensing of stress, strain, displacement, and natural frequency to diagnose distress in structural elements. The fault diagnostics system must be robust to have a service life at least as long as the service life of the structure in which it is installed.

PHASE I: Develop concepts and characteristics. Demonstrate performance by computer or other mathematical modeling. PHASE II: Conduct laboratory tests to demonstrate diagnostic system integration into waterfront structure.

PHASE III. Construct and install diagnostic system into pier components at NFESC's Advanced Waterfront Test Site at Port Hueneme and validate performance tests. Validate the technology through an accepted industry standard accreditation office such as the Innovation Technology Evaluation Center.

COMMERCIAL POTENTIAL: This research encompasses sensor systems. In addition to commercial ports this technology base is applicable to the nation's highway bridges in need of health monitoring. This technology base will present a fertile mix of innovative materials, techniques and systems that will reduce the time and cost of developing a low maintenance pier concept and will present opportunities for technical exchanges and coordinated efforts.

REFERENCES:
1. MILHDBK 1025/1
2. New Materials for Prestressing and Monitoring Heavy Structures, CONCRETE INTERNATIONAL, Sept 1989.
3. Fiber-Optic Sensors for Concrete Strain/Stress Measurement, ACI MATERIALS JOURNAL, May/June, 1991.
4. An Integrated Fiber Optic Strain Sensor, ADVANCED CONSTRUCTION TECHNOLOGY CENTER Document No. 92-20-01, Mar 1992.
5. Smart Structures, CIVIL ENGINEERING, Nov 1992.
6. Non-Intrusive Quality Health Monitoring of Composite Reinforcement Applied to Norfolk Pier 11, CENTER FOR INTELLIGENT MATERIAL SYSTEMS AND STRUCTURES, Jan 1997.
7. Fiber-Optic Bragg Grating Sensors for Bridge Monitoring, CEMENT & CONCRETE COMPOSITES Special Issue on Fiber Optic Sensors, Feb 1997.
8. Waterfront Repair and Upgrade Advanced Technology Demonstration Site No.2: Pier 12 Naval Station San Diego, NAVAL FACILITIES ENGINEERING SERVICE CENTER SSR-2419-SHR, Nov 1998.

KEYWORDS: Composites; Structural Fault Diagnostics; Waterfront Infrastructure

N99-207 TITLE: Scriptable Human Animation Figures in an Open Environmental Framework

TECHNOLOGY AREAS: Modeling

OBJECTIVE: Provide the designers of complex human systems a tool to script human motor task behavior in perceptual, cognitive, ecological and physically correct environments for ergonomic simulations.

DESCRIPTION: Available animation-based ergonomic tools are quasi-manual in programming human motor activities in weak simulated environments. The design iteration speed and quality is limited due to the human figure programming effort and lack of suitable embedding environments.

PHASE I: Research a pathway from human neuromotor behavior to kinematically, dynamically correct behavior in simulated potential ergonomic and physical environments. Develop an open framework for integrating perceptual, cognitive and visualization tools for ergonomic design.

PHASE II: Develop human motor simulator model software, situation knowledge database and interfaces to other design tools using the open framework. Research and develop a scripting interface to the simulated figures that utilizes elements-part or whole-of design descriptions used by the system architects for the product.

PHASE III: Offer scripting and knowledge database to human engineers, training and job designers, industrial and ergonomic analysts in the area of complex systems where human behavior is an essential element. Disseminate to design community for use in all areas where human motor behavior is of consequence and scripting is necessary to achieve human integration verification within the time constraints of other parallel system design disciplines that currently have better developed tool sets.

COMMERCIAL POTENTIAL: Can be applied in any area where human motor behavior in complex environments can be predicted the extent necessary to reduce analysis time, mock-up and prototype costs.

REFERENCES:
1. DD 21 Request For Proposal, Solicitation N00024-98-R-2300
2. Broad Agency Announcement N00024-98-R-6332

KEYWORDS: Ergonomic design in complex systems, virtual figure scripting, and human motor task analysis

N99-208 TITLE: Lightweight and Inexpensive Rigid Construction Paneling Material

TECHNOLOGY AREAS: Materials

OBJECTIVE: To further develop strong, lightweight and inexpensive rigid construction paneling materials rendering them suitable for exterior expeditionary uses.

DESCRIPTION: Expeditionary operations require materials that are lightweight, versatile, environmentally sound, and durable for construction of temporary rigid structures (i.e. shelters, quansit huts). Most rigid construction paneling materials such as wood, metal, and plastics tend to be heavy thus increasing transportation costs. The lightweight rigid construction materials such as wood or metal composites tend to be expensive increasing capital costs. A variety of strong, lightweight, and inexpensive ($0.63/ft2) rigid fiberboards made from recycled and/or bio-based materials are currently on the market. However, these materials currently lack weather-resisting properties rendering them unsuitable for exterior expeditionary use. Some of these fiberboards are 18 lb/ft3 yet still meet ANSI A208.1 requirements for LD-2 particle board. In addition, these fiberboards can be molded into curved shapes without spring- back eliminating the need for framing. Other suitable fiberboard materials may also exist which meet or exceed above specifications. This project seeks to reduce expeditionary costs for temporary shelters without compromising performance by further developing lightweight materials.

Table 1: Characteristics of Various Rigid Construction Materials

Construction Material	Material Tensile(psi)	Material Thickness(inch)	Material Density (lb.ft3)
6061-T6 Aluminum	45,000	0.05	168.5
Oak (white)	11,300	0.20	43.4
SAE 1010 Steel	53,000	0.04	490.0
HDPE	4,000	0.57	59
Molded Fiberboard	5,000	0.75	18

PHASE I: Identify promising candidate materials, coatings and fiberboards, that can potentially meet expeditionary needs while reducing costs and maintaining environmental soundness. Test material combinations to ensure suitability for expeditionary use without adding significant weight (<3lb/ft3).

PHASE II: Develop rigid collapsible and stackable modular shelters that are capable of being erected in the field without specialized tools or equipment.

PHASE III: Develop appropriate specifications/documentation to make the system standard in the fleet. Complete strategy for incorporating the specifications of the products with the various national accrediting agencies.

COMMERCIAL POTENTIAL: This technology development could provide inexpensive temporary shelter for humanitarian services. The developed product may also be used for temporary exterior construction projects such as bracing and sheeting for concrete foundations, shoring trenches in pipeline operations, excavation operations, and temporary construction of barrier walls for indoor and outdoor asbestos removal projects.

REFERENCES:

1. Naval Facilities Engineering Service Center(NFESC). Technical Memorandum TM-2217-AMP. "A Survey of Commercial Packaging and Handling" by Brian Cable, Sept 1996
2. Naval Facilities Engineering Service Center(NFESC). Technical Memorandum TM-2265-AMP. "A Cargo Supply Methodology for USMC Expeditionary Deployments" by Brian Cable, October 1997

KEYWORDS: Temporary Shelter; Rigid Construction Material; Collapsible Structures; Expeditionary; Lightweight Fiberboards; Economical; Environmentally Friendly

N99-209 TITLE: Constructed Wetland System for Treatment of Washrack Effluent

TECHNOLOGY AREAS: Environmental

OBJECTIVE: Develop and commercialize a compact constructed wetland system for treating industrial washrack effluents.

DESCRIPTION: Commercial and DOD industrial facilities need a treatment system that can easily and inexpensively treat washrack effluent. Constructed wetland technology has the capability to fulfill this need. However, the extensive land requirements can make treatment of wetlands an unacceptable option. Development is needed to create a compact system that will work in an industrial environment.

A compact wetland system should be applicable or adaptable to washrack effluent streams that vary in flowrate, volume, composition, and contaminant concentration. For example, the product should be capable of treating heavy metals from an aircraft washrack effluent and solids from vehicle washrack effluent. It should be very low maintenance, have capital costs comparable to existing systems for similar purposes, not generate appreciable secondary waste-streams, and meet the requirements of an industrial setting (i.e. minimal area requirements).

Additional requirements include (1) easily meeting or exceeding existing and proposed standards applicable to industrial washracks (2) protection of human health and the environment, (3) operation without material replacement or chemical addition, and (4) simplicity of design and operation to minimize possibility of breakdown.

PHASE I: Develop a design and bench-scale or full-scale system that meets the above criteria. The system should be tested with appropriate washrack effluent streams to generate preliminary performance data.

PHASE II: From the Phase I effort, develop a fully functional prototype system. The prototype will be performance tested and demonstrated on washrack effluent at a military installation. This phase will proceed according to demonstration plan and quality assurance project plan approved by the government. An evaluation report shall be delivered within three (3) months of the test(s) completion.

PHASE III: Validate the technology to a certification organization or regulatory agency approved according to a validation plan approved by the government. Create user-friendly manuals, effective marketing tools, and presentation materials. Develop strategies to facilitate system implementation in "real world" scenarios. Identify and develop tools and techniques for overcoming implementation barriers.

COMMERCIAL POTENTIAL: A system that meets the objectives of this effort has tremendous potential for sale and use in the United States and abroad. The treatment concepts, those dealing with specific contaminants would have wide application in the field of environmental pollution control - not limited to wetland applications. The flexibility offered by the proposed technology will benefit environmental consultants, planners, regulators, and facility managers as they respond to changes in technology and regulations. By increasing treatment options, manufacturers of pollution control technology would benefit.

KEYWORDS: Washrack; Constructed Wetland; Industrial; Effluent; Vehicle; Aircraft

N99-210 TITLE: Carbon Composite Reinforcement For Concrete Waterfront Construction

TECHNOLOGY AREAS: Materials

OBJECTIVE: Develop innovative, cost competitive, carbon fiber composite reinforcement for Navy waterfront construction.

DESCRIPTION: The Navy is demonstrating the feasibility of constructing waterfront pier and wharf structures using high performance concrete and FRP composite materials to meet changes in ship characteristics, force realignments, and rapid buildup of infrastructure. The structural designs will maximize maintenance free service life while providing a competitive initial cost with conventional construction. The Navy has a need to develop innovative, high strength, high modulus reinforcement for its high performance lightweight concrete waterfront infrastructure. The reinforcement will be used for both conventional and pre-stressed concrete construction and can be configured in any geometry that exploits the strengths of FRP composite materials and bonds well with concrete. The Navy is particularly interested in reinforcement that does not mimic traditional bars, tendons and mesh. Epoxy and other polymer rich surfaces of FRP do not chemically bond well when cast in concrete. Therefore, it is prone to bond failure under impact loads normal to the FRP surface. The reinforcement must be robust to perform without degradation for a service life of at least 100 years. In order to compete with conventional steel reinforcement and prestress steel, the FRP should possess comparable stiffness properties to that of steel and have tensiles strengths in the order of 400 - 500 KSI (2800 - 3400 MPa).

PHASE I: Develop reinforcement concepts and characteristics. Demonstrate performance by computer models or otherwise.

PHASE II: Conduct laboratory tests to demonstrate reinforcement system integration into waterfront structures.

PHASE III: Construct half scale structural systems at NFESC's Advanced Waterfront Test Site at Port Hueneme and initiate performance tests. Validate the technology through an established Navy demonstration program or through an accepted industry standard accreditation office such as the Innovation Technology Evaluation Center.

COMMERCIAL POTENTIAL : This research encompasses alternatives to steel reinforcement that is inherently corrosive in a chloride environment on the waterfront. In addition to commercial ports this technology base is applicable to the nation's highway bridges in need of non-corrosive reinforcing systems for concrete. This technology base will present a fertile mix of innovative materials, techniques and systems that will reduce the time and cost of developing a low maintenance pier concept and will present opportunities for technical exchanges and coordinated efforts.

REFERENCES:
1. MILHDBK 1025/1

2. Tensile and Bond Properties of FRP Rebars, ACI MATERIALS JOURNAL, May/June 1995.
3. Bond Stress-Slip Characteristics of FRP Rebars, NAVAL FACILITIES ENGINEERING SERVICE CENTER R-2013-SHR, Feb 1994.
4. Waterfront Repair And Upgrade Advanced Technology Demonstration Site No. 2: Pier 12 Naval Station San Diego, NAVAL FACILITIES ENGINEERING SERVICE CENTER SSR-2419-SHR, Nov 1998.
5. A Look at the World's FRP Composites Bridges, MARKET DEVELOPMENT ALLIANCE of the SPI COMPOSITES INSTITUTE, 1998.
6. FRP Concrete Composite Pier N47408-98-C-7529, BERGER ABAM for the NAVAL FACILITIES ENGINEERING SERVICE CENTER, Apr 1999.

KEYWORDS: Composites; FRP composite reinforcement, waterfront infrastructure

N99-211 TITLE: Automated Electromagnetic Optimization for Advanced Antenna Design

TECHNOLOGY AREAS: Modeling

OBJECTIVE: Create an antenna design modeling suite, utilizing existing validated electromagnetic codes, for the purpose of automated optimization, requiring a minimum of operator interaction.

DESCRIPTION: Embed state-of-the-art optimization routines in a feedback loop between existing electromagnetic codes and geometry meshers, permitting automated design of complex antenna structures. This package must compute an error function based upon the output of the code, and iteratively modify the structure geometry in order to minimize a user defined error function over a constrained multi-dimensional space.

PHASE I: Compare and identify one or more suitable optimization algorithms. Using the Numerical Electromagnetic Code as a testbed, develop a prototype optimizer that can use several different algorithms such as WIPL & EIGER. Each algorithm should be performance tested on a variety of antenna problems (such as the UHF Electronically scanned array) for convergence time, ability to find optimal solutions, etc.

PHASE II: Continue development, performance characterization, and prepare a graphical user interface. Develop coarse grain parallelization.

PHASE III: Graduate the developed product to one of several moment method codes having more generalized structures. This will likely involve interfacing the optimizer to meshing programs such as IDEAS, PATRAN, etc.

COMMERCIAL POTENTIAL: Numerous electronics firms involved with the design of antennas, filters, etc. use the same electromagnetic codes and face the same problems. This product would be completely applicable to the commercial sector ? cellular phone industry, automotive industry, etc.

KEYWORDS: Automation, Electromagnetic Modeling, optimization

N99-212 TITLE: SMART Damage Control Boundary Opening System

TECHNOLOGY AREAS: Materials, Sensors

OBJECTIVE: Provide a damage control boundary opening system that prevents water, air, and fire from passing through the boundary when a damage control condition (flooding, chemical/biological agents present, or fire) exists. The boundary opening system must also allow the passage of people and cargo during non damage control conditions.

DESCRIPTION: Navy damage control boundaries provide structural integrity, prevent flood progression, prevent fire progression, prevent the passage of chemical/biological agents, and prevent weather intrusion. These boundaries typically consist of structural steel panels with steel stiffeners. To allow for the passage of personnel and cargo, openings are cut in the steel panels and doors installed to prevent the passage of the above mentioned elements. In an effort to maintain watertight/airtight integrity, the Navy is spending $38M per year in maintaining and fixing watertight/airtight doors; however, INSURV inspections indicate only 50 to 75% of the fleet's 52,000 doors meet watertight/airtight integrity requirements. It is extremely rare that a door is ever called upon to perform its watertight function yet many of these doors and their associated dog system are being cycled more than 1000 times a day. The Navy needs a reliable, maintenance free, smart, damage control boundary opening system that allows people and cargo to pass through (99% of the time) but prevents water, air, and fire from passing though when a damage control condition exists. Through the use of advanced technologies (sensors, materials, processes, etc.), the opportunity exists for the Navy to significantly reduce the cost of maintaining damage control boundary opening systems.

PHASE I: Conduct a cost and feasibility analysis and design a damage control boundary opening system that will sense a watertight/airtight condition and respond by preventing passage of water, air and flame.

PHASE II: Develop a prototype system and demonstrate the watertight/airtight boundary response time to a watertight/airtight condition and demonstrate the reliability of the system.

PHASE III: Transition system design to commercial and military ship applications.

COMMERCIAL POTENTIAL: U.S., Foreign Commercial, and military ships of the future will be operated with very small crews. The specialized resources required to maintain, fix, inspect, and provide specialized training to ensure watertight integrity with the current technology will be unaffordable in the future. Development of a new and proven technology that can be uniformly applied to commercial as well as military ships will be readily adopted as a cost effective measure.

KEYWORDS: Damage Control; Watertight; Airtight; Flametight; Door; Boundary

N99-213 TITLE: Non-Cooperative Moving Target Recognition Using ISAR

TECHNOLOGY AREAS: Computing

Objective: Develop algorithms capable of real-time ISAR radar imaging of maneuvering aircraft, small ships at sea, and moving ground vehicles. Demonstrate the capability of extracting reliable target features useful for non-cooperative target classification. Develop and demonstrate target classification processes and algorithms that can accommodate approximately 30 different target classes.

PHASE I. Demonstrate ability to form ISAR images of moving targets such as ground vehicles, small ships, and aircraft and the ability to robustly extract target features that can be used for automated target classification. These capabilities must be demonstrated at all target aspect angles and for a variety of target motion. The government COTR will provide a controlled data set (UNCLASSIFIED) of aircraft and/or ship targets to be imaged (raw I/Q data will be provided) to all phase 1 participants.

PHASE II. The government COTR will provide a more extensive data set of moving targets. The phase II contractor(s) will optimize their feature extraction methods and develop robust classification processes based on this data set. This data set will also be unclassified, however restricted data can also be provided if the contractor possesses the necessary clearances. Phase II efforts will culminate by having the government conduct an independent evaluation of algorithm performance (image formation algorithms, feature extraction, classifier performance, etc.). A sequestered data set reserved for this purpose will be provided. This evaluation can either be done at contractor facilities with COTR participation, or by delivering all algorithms to the COTR.

PHASE III. The COTR will facilitate the incorporation of compelling phase II results into appropriate Navy funded programs; e.g. Small Craft Automatic Target Recognition (SCATR) & All-Aspect Complex Target ID Variable Engagements (ACTIVE). The contractor is also encouraged to develop relationships with suitable aerospace companies capable of integrating phase II products into weapons systems. The Navy will consider suitable proposals on a yearly basis and envisions the SBIR contractor would be listed as a sub-contractor in the proposal. Alternatively, the SBIR contractor can propose on its own if it has the necessary resources.

COMMERCIAL POTENTIAL: The ability to include an effective non-cooperative moving target recognition capability is required for Navy airborne and shipborne radar. Existing methods must be improved to provide reliable all sensor/target aspect angles, and to accommodate large numbers of targets with similar appearance. All industries involved with DoD surveillance, reconnaissance and strike technology will benefit from this SBIR program. In addition, algorithms capable of providing well focussed real-time radar imagery of moving targets can readily be adapted for real-time medical imagery, such as magnetic resonance imaging, so the medical community will also benefit from this program.

REFERENCES:
1. NATO RTO Meeting Proceedings 6, Non-Cooperative Air Target Identification Using Radar, RTO-MP-6, AC/323(SCI)TP/2, Proceedings of Symposium held in Mannheim GE between 22-24 April 1998, published Nov. 1988
2. Chen, C.C. and Andrews, H.C., A Target-Motion-Induced Radar Imaging,@ IEEE Trans. On AES, vol. 16, no.1. pp 2-14, 1980
3. Chen, V.C. and Miceli, W.J., A Time-Frequency Transforms for Radar Imaging of Maneuvering Targets,@ IEE Proceedings-Radar, Sonar, and Navigation, vol 145, no.5 pp 262-268, 1998

KEYWORDS: ISAR, radar imaging, moving target radar imaging, non-cooperative target recognition

N99-214 TITLE: Maritime Intelligence, Surveillance, Reconnaissance (ISR) and Space Exploitation

TECHNOLOGY AREAS: Command & Control(C3)

OBJECTIVE: Further the development of technology to automatically develop complete awareness of the littoral maritime situation long before, leading up to, during, and after military engagement.

DESCRIPTION: The focus of this SBIR topic is to stimulate bold new concepts for significantly increasing the performance of automated maritime ISR including use of space assets. The Century 21 Navy will need complete awareness of the subsurface and surface situation within a wide area of interest. This SBIR focuses on the littoral situation, which is complicated by the presence of many neutral surface ships of all sizes and purposes, as well as that of friendly and enemy combatants, including mines. Awareness must extend seamlessly across time, beginning well before and extending through hostilities. Situation awareness must be consistent among all involved. Situation awareness will be expressed in the form of a complete picture of who is where as a function of time. This picture will be available to all Naval personnel at an appropriate level of resolution (this SBIR focuses on aspects of maritime ISR other then conventional ASW and MCM since these are covered by other SBIR topics). Novel means of exploiting or improving existing sensors, including space sensors are of interest. Methods of detecting and classifying (or, in some cases, identifying) neutrals (commercial shipping, fishing and pleasure craft) and unusual threats such as small surface craft (i.e. 'Boghammers'2) and small submarines (mini-submarines) are of interest. Examples include but are not limited to: 1) surface ship surveillance exploiting ship acoustic, electromagnetic, or hydrodynamic signatures or, of particular interest, use of GPS signals or low resolution space based radar to illuminate the ocean surface; and 2) undersea surveillance via fusing of multistatic active acoustic sensing or novel matched field methods for autonomous deployed sensors. Methods of tracking entities of interest in the complex littoral environment are sought. The littoral scene may contain many objects with crossing paths and unknown motion models. Methods of maintaining a consistent awareness of the situation among Navy personnel who are dispersed and intermittently in contact with each other are sought.

PHASE I: Develop a complete algorithm or detailed description of the proposed ISR concept. If the concept involves hardware produce a design. This algorithm, description, or design and supporting documentation should be sufficient to convince qualified engineers that the proposed concept is technically feasible.

PHASE II: Produce and demonstrate performance of a computer program based on the algorithm or description of the concept. If the concept involves hardware, produce and demonstrate performance of an exploratory Development Model (XDM). Demonstrate performance in such a way as to convince qualified engineers that the proposed concept is capable of meeting requirements in an operational environment.

PHASE III: Team with the manufacturer of one of the Navy's ASW or MIW ISR systems to integrate the concept into future generations. Team with manufacturers of commercial fusion systems, such as air traffic or harbor control, to integrate the concept into these products.

COMMERCIAL POTENTIAL: There is a commercial market for ISR concepts applied to air traffic and harbor control. There is a growing commercial market in tracking littoral traffic for law enforcement (smuggling and illegal fishing).

REFERENCES:
Waltz, Edward and James Llinas, AMultisensor Data Fusion,@ Artech House, 1990,
Bar-Shalom, Y., ATracking Methods in a Multitarget Environment,@ IEEE Transactions on Automated Control, Vol. AC-R3, August 1978, pp. 618-626

KEYWORDS: Electromagnetic, Acoustic and Hydrodynamic signatures, multitarget tracking, state estimation, common tactical picture

N99-215 TITLE: Pressure-Tolerant Batteries for Undersea Applications

TECHNOLOGY AREAS: Electronics

DESCRIPTION: Small, rechargeable, pressure-tolerant batteries for use in autonomous underwater vehicles and in situ instruments are needed. Pressure-tolerant batteries operate effectively at depth in seawater without the use of a pressure case. Elimination of the pressure case effectively doubles the energy that can be carried for a given amount of buoyancy. These batteries will operate at pressures up to an equivalent of 4,000 m of sea water and in all orientations. Efficient recharging while at elevated pressure is required. Management of evolved gases during pressure cycling must be addressed. Objectives will likely be achieved through innovative packaging of state-of-the-art battery chemistries, for example, lithium polymer solid state systems. Specific energy of the battery system should be no less than 100Wh/kg with a minimum cycle life of 200 cycles. The cost goal is less than $1000/KWh.

PHASE I: The contractor will convincingly demonstrate the feasibility of the proposed technology to meet the desired requirements and cost.

PHASE II: The contractor will design, construct, test, demonstrate and document a prototype of the new technology, including performance specifications and estimated production cost.

PHASE III: The technology is expected to transition to a wide variety of in-situ ocean sensors and platforms used by the Navy, government laboratories, academia and industry. The successful developer will likely have a number of opportunities to participate in initial commercialization.

COMMERCIAL POTENTIAL: Beneficiaries of this technology include manufacturers of remote marine instrumentation. The autonomous underwater vehicle industry will benefit from lighter weight, rechargeable power supplies.

KEYWORDS: pressure; tolerant; batteries; undersea

N99-216 TITLE: Improve the Performance and Reduce the Cost of Central Components of Ocean Sampling Systems

TECHNOLOGY AREAS: Sensors

DESCRIPTION: An improved magnetic compass with an absolute accuracy of better than 0.5 degree in the horizontal components of the earth's magnetic field is needed. Calibration should be independent of location and time over a one year period. The unit should also provide two axes of tilt information each to an accuracy of 0.5 degree. Sampling frequency up to several times per second and power consumption under 10 milliwatts is required. The compass unit will operate in undersea and sea-surface environments with transient orientations and must withstand forces typical of shipboard deployments in moderate sea states, suggesting a solid state device. The cost goal is under $1000/unit.

PHASE I: The contractor will convincingly demonstrate the feasibility of the proposed technology to meet the desired requirements and cost.

PHASE II: The contractor will design, construct, test, demonstrate and document a prototype of the new technology, including performance specifications and estimated production cost.

PHASE III: The technology is expected to transition to a wide variety of in-situ ocean sensors and platforms used by the Navy, government laboratories, academia and industry. The successful developer will likely have a number of opportunities to participate in initial commercialization.

COMMERCIAL POTENTIAL: Beneficiaries of this technology include manufacturers of remote marine instrumentation that requires an accurate, long term geo-reference such as wind, wave and current sensors. The autonomous underwater vehicle industry will benefit from more accurate subsurface navigation.

KEYWORDS: magnetic; compass; geo-location; subsea navigation

N99-217 TITLE: Identification of Shallow Water Acoustic Environmental Parameters

TECHNOLOGY AREAS: Computing

OBJECTIVE: Improve shallow water applications of active sonar by estimating the acoustic environment in situ using properties of ownship's transmissions and bistatic/multistatic receptions.

DESCRIPTION: Shallow water applications for sonar are defined to be those applications where surface and bottom boundary interactions are present and dominate the propagation of typical acoustic paths from the transmitter to the target and the target to the receiver. In bistatic operations the receiver and the transmitter can be in separate locations. The bottom interaction depends on the seafloor composition, roughness, and structure of the sub-seafloor. Surface interactions depend on sea-state, the wind velocity vector, and the bubble fields generated. Active transmissions and local targets of opportunity or local bathymetric features, along with direct transmissions from the transmitter to receiver, can provide information which will aid in the estimation of reverberation levels, clutter maps, multipath effects, normal-mode excitations and ray paths. Estimation of these parameters can aid in best operational resource selections. In addition, signal processing procedures such as multipath recombining can use this knowledge to improve detection and tracking performance. Innovative techniques are required to provide useful estimates of environmental parameters for improved shallow water processing.

PHASE I: Initial feasibility studies will be conducted to begin development of a set of algorithms to estimate the acoustic environment in situ and to determine the relevant shallow water sonar parameters. The Generic Sonar Model (GSM) will analyze the performance of the proposed algorithms using simulated data such as that produced.

PHASE II: Further development of selected algorithms will be performed, using real sea data for regions of known propagation conditions. Algorithms will be evaluated based on their ability to mitigate the problems associated with shallow water sonar.

PHASE III: Successful algorithms will be integrated into envi-ronmental models used for performance prediction purposes.

COMMERCIAL POTENTIAL: The techniques developed under this topic would be applicable to many situations involving complex propaga-tion of waves. Examples include cellular telephony, weather radar, medical imaging and seismology.

REFERENCES:

1. Isabel, M.G., Lourtie and G. Clifford Carter, ASignal Detec-tion in the Presence of Inaccurate Multipath Time Delay Modeling@ J. Acoust. Soc. Am., 88(6):2692-2694, December 1990.

2. Ainslie, M.A., et al., ASignal and Reverberation Prediction for Active Sonar by Adding Acoustic Components@, IEE Proceedings for Radar, Sonar, and Navigation, 143(3), June 1996.

KEYWORDS: Acoustic Propagation; Shallow Water Acoustics; Multipath; Recombining; Sonar; Signal Processing

N99-218 TITLE: Simulation Based Acquisition Development Environment

TECHNOLOGY AREAS: Modeling

OBJECTIVE: Design an architecture to support the Simulation Based Acquisition (SBA)

DESCRIPTION: The Department of Defense (DoD), faced with decreasing budgets, has developed several initiatives which focus on obtaining the maximum effectiveness from its total resources. One such initiative is Simulation Based Acquisition or SBA and its major components: the Smart Product Model (SPM) and the Simulation Test and Evaluation Process (STEP). The objective is to: 1. Design an architecture to support the Simulation Based Acquisition (SBA) of future surface combatants, consistent with DoD requirements 2. Demonstrate the life cycle applicability of virtual prototype, i.e. Smart Product Model, to support SBA to ship acquisition. While research into SBA and SPM have been sponsored for the past few years by the Defense Advanced Research Projects Agency (DARPA), there are many applications, each with their own set of challenges, that must be developed and applied in order to gain their full benefits.

PHASE I: Define a virtual product model of at least one major ship system and infrastructure addressing interoperability and standards. Define an information flow model for driving the virtual product model. Identify any incompatibilities or other problems that interoperability and standards that might impose on SBA limiting its use for ship acquisition. Demonstrate the design supporting the application of SBA to ship acquisition.

PHASE II: Develop and test the SBA tool for at least one major ship system virtual prototype that can be used to perform life cycle analyses that demonstrate the use of SBA to affect design, manufacturing, testing, training, and operational procedures in the ship acquisition process.

PHASE III: Demonstrate, extend and deploy the SBA tool in support of a broad variety of Naval and Defense acquisition programs and commercial industry systems/products.

COMMERCIAL POTENTIAL: This SBA tool can be applied to any complex product development such as the Boeing 777 or the Chrysler automotive Cybersynthesisϑ process.

REFERENCE: "The SBD Smart Product Model Architecture - Overview", SBD-SYS-13, Lockheed Martin, DARPA Contract MDA 972-95-D-0003, 13 February 1997.

KEYWORDS: Simulation Based Acquisition; Modeling; Simulation; Smart Product Model; Distributed Architecture; High Level Architecture

N99-219 TITLE: In-Situ Device for the Measurement of Gas in Shallow Sea Floor Sediments

TECHNOLOGY AREAS: Battlespace

OBJECTIVE: Rapid and accurate in-situ determination of the gas content of shallow water marine sediments to ascertain it's affect on shock waves and other explosive phenomena, thereby enhancing Naval capabilities at the beach head during amphibious operations.

DESCRIPTION: Gas bubbles are known to exist in various shallow-water deposits and to modify important sediment properties including the acoustic response, the permeability, the electrical conductivity and static and dynamic geo-technical properties. Gas bubbles have a major impact on the transport and the accumulation of materials (water and dissolved and suspended matter) and energy through the sediment pore network. Free gas imposes a significant acoustic impedance mismatch between the gas phase and the surrounding interstitial water and solids. This affects not only the attenuation or energy absorption but also the reflection of acoustic energy. Understanding the degree of saturation in marine sediments is crucial in the modeling and prediction of pressure attenuation, energy transmission, and fluid flow through shallow water deposits. At present, however, no satisfactory in situ method of quantitatively measuring the degree of saturation exists.

PHASE I: Design and test a system to measure the insitu gas content of the upper meter of a variety of marine sediment types in water depths ranging from the surf zone (<1 meter) to 100 meters. Vertical resolution of the system should be selectable over the centimeter to decimeter range. This design and supporting documentation should be of sufficient detail to convince qualified engineers that the proposed concept is technically feasible.

PHASE II: Produce and demonstrate performance of a prototype device in a number of well characterized sedimentary environments that contain different classes of sediment, and varying gas contents. Demonstrated performance should be in such a way to convince qualified engineers that the device is capable of meeting requirements in an operational environment.

PHASE III: Team with the developers of the naval MCM systems to integrate the concept into future generations.

COMMERCIAL POTENTIAL: Team with manufacturers of commercial environmental measuring devices, such as for offshore engineering requirements, pollution related harbor reclamation or ecosystem monitoring, to integrate the concept into commercial products. This system has strong dual use ranging from civil engineering to pollution related harbor reclamation and ecosystem habitat studies. Offshore engineering companies servicing the oil industry have a long standing need for this type of system.

REFERENCES:

1. M.H. Hubert and R.H. Bennett, 1982: Anomalous Pore Pressures in Mississippi Delta sediments: gas and electrochemical effects; Marine Geology, 5, p 51-62
2. R.H. Bennett, 1992: Geo-acoustic and Geological Characterization of Surficial Marine Sediments by In Situ Probe and Remote Sensing Techniques, in CRC Handbook of Geophysical Exploration at Sea, CRC Press, Boca Raton, p 295-350.

KEYWORDS: Gas; in-situ; sediment; Sea floor; measurement; shallow water.

N99-220 TITLE: Bright Ultra-cold Positron Beam Source for Chemical and Materials Analysis

TECHNOLOGY AREAS: Electronics, Materials

OBJECTIVE: Novel techniques are sought for the production of bright, ultra-cold positron beams with small diameter and high efficiencies.

DESCRIPTION: Low energy positrons have unique capabilities to characterize surfaces and solids for material interactions(1), mass spectrometry (2) and in atomic, molecular and plasma physics (3). This is due, in part, to the annihilation radiation they produce when combined with electrons. Conventional technique (1) are limited in efficiency and the lowest temperature that can be achieved. Novel techniques are sought for the production of bright cold positron beams. This effort will take advantage of the latest scientific developments in positron sources and storage devices to develop an apparatus that will produce ultra-cold, low energy positron beam apparatus.

PHASE I: Develop the designs of a bright ultra-cold positron beam sources and demonstrates the feasibility of the key components.

PHASE II: Build and test a bright ultra-cold positron beam source.

PHASE III: Build a "turn key" bright ultra-cold positron beam source.

COMMERCIAL POTENTIAL: This system could be used as a diagnostic tool in a wide variety of applications. For example it may be used on microelectronics production line. It has the potential of providing a unique approach to environmental testing.

REFERENCES:
1. P.J. Schultz and K. G. Lynn, "Interactions of positron beams with surfaces, thin films, and interfaces," Reviews of Modern Physics, 60, 701 (1988)
2. L. D. Hulett et al., "Mass spectrometry studies of the ionization of organic molecules by low-energy positrons," Chemical Physics Letters, 216 236 (1993)
3. W. E. Kauppila and T. S. Stein, Comparisons of Positron and Electron Scattering by Gases," Advances in Atomic, Molecular, and Optical Physics 26, (1990)

KEY WORDS: Positron, Beam, Diagnostics, Ionization, Annihilation, Radiation

N99-221 TITLE: Extended Torso Garment for Tactile Transduction

TECHNOLOGY AREAS: Clothing & Textiles

OBJECTIVE: Enable garmentry that provides a consistent human torso skin interface for tactile transduction applications for operators in harsh envirornments.

DESCRIPTION: Tactile displays have proven useful to provide situation awareness information in field tests in aviation and undersea environments. These tested displays utilize small, light weight tactile transducers ("tactors") that are placed in arrays surrounding the torso to provide a three dimensional representation of the world space surrounding the operator. A wide variety of three dimensional information may be presented such as course deviations, spatial orientation, target locations, etc. In order to accurately represent three dimensional space on the torso, tactors must be placed in a body garment extending from the mid thigh to the neck, including the upper arms. For operators to trust a tactile display system, it must provide reliable, consistent contact force with the body of the wearer. To enhance user acceptance, the garment should provide a comfortable constant temperature to the skin and operators must be able to easily don and doff the tactile display garment.

PHASE I: Develop a torso garment design for the Tactile Situation Awareness System. Such a garment will reach from the neck to the mid thigh with a simple closure. It will provide mounting for and consistent contact force at the skin for a variety of tactile transducers. This garment design will allow for servicing of tactors, and connection of tactor control lines via umbilical or other means. The garment must be scaleable for small, medium and large sizes and should be easily adjustable to accommodate a variety of body habitus.

PHASE II: Develop and test torso garments with Tactile Situation Awareness System operations in simulated and/or actual aviation, undersea and space environments.

PHASE III: Develop robust tactor garments of appropriate certified materials for use in military and general aviation and military and commercial diving operations.

COMMERCIAL POTENTIAL: This development could be used in any environment that would benefit from a non-visual non-competing information display in harsh or mild environments. In addition displays resulting from this development could be used to augment human machine interfaces in many applications and could also be used a framework for biosensing applications.

REFERENCES: Numerically list any readily available references that would be helpful in solving the problem

KEYWORDS: Tactile Interface; Tactor; Garment; Situation Awareness; Biosensing; Human Machine Interface

N99-222 TITLE: Self Regenerating Controller for High Power Magnetostrictive Devices

TECHNOLOGY AREAS: Surface

OBJECTIVE: Investigate new electronic topologies to provide force and motion control of multi-phase, inductively coupled actuators in the 4,000 to 15,000 pound-force linear thrust range.

DESCRIPTION: In the ongoing effort to engineer an all-electric ship and eliminate hydraulic systems from surface combatants, a new generation of high force/torque actuators/motors will be necessary. One such system utilizes inductively coupled, direct acting intermetallic elements that convert magnetic energy directly into motive energy. The major drawback in designing compact heavy duty, magneto-mechanical systems has been clearly identified by the Navy as the drive electronics. The fundamental operation of magneto-mechanical system mandates high energization at fast slew rates. The present use of linear power electronics is not capable of meeting specifications and incur prohibitively large weight and power penalties for almost all heavy duty applications such as hatch /door closures, machinery isolation or valve control that require the unique ability of magneto-mechanical systems to achieve actuation authority not available in conventional mechanisms and devices. The goal of this SBIR is to provide a full solution to this dominant issue. Efficient use and control of these devices will require a system capable of re-utilizing the back EMF induced in each segment, frequency of operation up to 10 kHz, current levels per phase up to 100 Amps, total phasing control, and self-sensing diagnostic abilities.

PHASE I: Develop a preliminary design. Fabricate and test a multi-phase segment prototype for a typical system application. Prototype to be capable of a minimum of 100 amps per phase at 4 kiloHertz.

PHASE II: Develop a full up system of the optimal design. Test system in conjunction with an actuator set to address a current Navy usage problem. Demonstrate private sector applications. Demonstrate the ability of the system to control multiple actuators. Make maximum use of standardized components.

PHASE III: Transition equipment and technology to new ship construction such as DD21. Transition equipment and technology to commercial shipbuilding companies.

COMMERCIAL POTENTIAL: The results of this research will have immediate impact on the efforts to commercialize magneto-mechanical systems both for military applications and non-military products. The introduction of a lighter weight compact, practical design for energization of inductively couple actuators at high frequency would overcome the single principle obstacle to the ready availability of this technology both to commercial markets and Navy adoption. Transitions that are anticipated for new ship construction includes: ADCX, DD21, and LHX. Equipment to be affected include: aircraft elevators, anchor windlasses, bow thrusters, cargo weapons elevators, cranes, conveyors, davits, fin stabilizers, steering, and underway replenishment. Commercial transitions are anticipated to ventures that will replace medium to heavy equipment machinery such as hydraulic actuators, palletization automation, machine tool positioners, and high torque - low speed motors.

REFERENCES:
1. "Design of Power Actuator Systems", G.G. Zipfel, Jr and G.W. Terpay, internal document, AT&T Bell Laboratories, Wippany, NJ, Jan. 25, 1994.
2. "Energy-Based Comparison of Solid State Actuators", V. Giurgiutiu, Z. Chaudhry, and C.A. Rogers, Report # CIMSS 95-101, Virginia Polytechnic Inst., Blacksburg, VA, September 1995.

KEYWORDS: Actuators; Regeneration; Inductors; All electric ship; Motors; control surfaces; elevators

N99-223 TITLE: <u>Mine Blast Seat Attenuation System</u>

TECHNOLOGY AREAS: Surface/Ground Vehicles

OBJECTIVE: Develop a lightweight, bracket-mounted troop seat capable of attenuating the ballistic shock effect of a mine to below the level of personnel injury.

DESCRIPTION: The Advanced Amphibious Assault Vehicle (AAAV) is designed to transport 17-18 embarked infantry under light armor from ships at sea to inland objectives over a variety of terrain. Ballistic shock transmitted to embarked troops following the detonation of a mine via the hull and troop seating is a concern. DRPM AAA seeks a lightweight, bracket-mounted troop seat capable of attenuating ballistic shock delivered by a reasonable sized land mine detonated under the vehicle to below levels that will produce personnel incapacitation. The seat must also insure acceptable ride quality in a AAAV in land and sea operational modes. A vehicle set contains 17 troop seats. Seats must be designed so that they flip up or otherwise automatically stow out of the way of troops rapidly exiting the vehicle. The seats must weigh no more than 17.7 lbs apiece and cost less than $885.00 apiece.

PHASE I: Develop and demonstrate a prototype troop seat capable of attenuating the ballistic shock effect of a mine to below levels that will produce personnel incapacitation. The vendor must demonstrate that the prototype produces the desired level of attenuation while being as lightweight and compact as possible. Provision for automatic return to a stowed position that does not inhibit rapid troop egress from the vehicle under emergency or combat deployment conditions is also required.

PHASE II: Develop, deliver, and demonstrate a prototype seat that will attenuate the ballistic shock effect of a mine to below the level of personnel injury.

PHASE III: Develop a fully capable seat and demonstrate the effectiveness of those seats in attenuating blast effects through live fire tests. Market the seat to combat vehicle, aircraft and ship designers. Modify the seat as necessary to address threat, material and shock conditions of interest to other combat and tactical vehicles as well as aircraft, ship designers.

COMMERCIAL POTENTIAL: Potential exists for application of this seat in the construction of armored cars, limousines, embassy buildings, law enforcement vehicles, ship, boats, helicopters, aircraft, and other systems that require protection of personnel from mechanical shock loads.

KEYWORDS: Ballistic shock, mine blast, protection, seats.

N99-224 TITLE: Advanced Concepts for Hull Array Beamforming Technology

TECHNOLOGY AREAS: Computing

OBJECTIVE: Improve the active sonar performance of hull mounted volumetric arrays in the presence of reverberation.

DESCRIPTION: Develop, implement, and demonstrate the utility of rapidly convergent adaptive beamforming (ABF) techniques for volumetric arrays (three dimensional array geometry) that can improve signal to noise ratio at the beam output by rejecting reverberation without suppressing returns from targets of interest. Techniques should be able to form beams in vertical and horizontal directions.

PHASE I: Characterize hull-mounted array reverberation noise statistics using existing sea test data and leveraging from on-going Navy sea tests. Develop techniques to exploit hull array noise characteristics in an adaptive algorithm to minimize reverberation contamination at the beamformer output. Develop and analyze models of candidate adaptive beamformer algorithms. Quantify potential benefits of alternate approaches based on noise gain improvement, minimum loss of signal gain, adaptation convergence rate, and estimated computational efficiency. Deliver a summary report with recommendations for phase II.

PHASE II: Develop prototype hull array adaptive beamformer algorithms and integrate into an analysis processing architecture. Using at-sea data recordings, perform a comparative analysis of algorithm performance from quantitative and qualitative measurements, including active acoustic detection displays. Refine algorithm adaptation parameters to achieve robust performance across a variety of active reverberation environments. Deliver a summary report with recommendations for Phase III.

PHASE III: Phase III tasking will include implementation and integration of an adaptive beamforming capability in an operational hull array sonar system. A final system specification, system design, and interface design shall be developed for initial production of this beamformer. System testing will include an operational demonstration of beamformer performance and robustness in diverse acoustic environments.

COMMERCIAL POTENTIAL: Other applications of the techniques developed in this SBIR are merchant ship sonar and fathometers, geophysical exploration, ocean salvage and mapping, seismic array processing for detection of under ground testing of nuclear weapons, ultrasonic medical imaging, and phased array radar.

REFERENCES: H. Cox, "Improved DMR," Adaptive Signal Array Processing Workshop, MIT Lincoln Laboratory, 1998.

KEYWORDS: active sonar; volumetric arrays; adaptive beamforming